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Editorial Comments

Piræus, the Port of Athens.

Piræus was founded in the fifth century B.C. and like many other cities and historic buildings in Greece, reminds us of her glorious past. The vicinity of the harbour entrance, in the waters lying between Piræus and Salamis, was the scene, in 480 B.C., of the famous naval battle of Salamis, where the Greeks destroyed the fleet of the Persians and, following this by defeating the Persian army on land, saved Europe from a barbarian invasion. The century and a half that followed was one of great splendour for Greek civilisation, at the head and centre of which was Athens.

Immediately after the defeat of the Persians, the Athenian statesman, Themistocles, founded the Port of Piræus which, within a few years, became one of the largest ports of the ancient world, with fine quays, large warehouses and many trading stores, shipyards, marble mansions, and temples and in addition a special naval-yard. The port continued to flourish until the rise of the Roman Empire; it was utterly destroyed by the Romans in 86 B.C., who left nothing but ruins and debris, and in this state the port remained for centuries.

Greece was part of the Ottoman Empire for a period of 370 years, and following the successful insurrection against the Turkish rule, Piræus was liberated in 1824. With Athens as the capital city, the port began to revive, gradually becoming one of the five major ports of the Mediterranean. In 1932 an extensive modernisation scheme, submitted by various authorities at the invitation of the Port Commission, was put in hand, and improvement works were continued until the outbreak of the recent war. Unfortunately, during the hostilities and German occupation, the port again suffered widespread destruction akin to that wrought in Roman times. Quay walls, warehouses and other port equipment were completely destroyed, so that all port activities were paralysed.

On a following page, we are privileged to publish a specially contributed article in which is described the growth of the port, together with the reconstruction programme which has been carried out since the cessation of hostilities. The review of the work involved gives an impressive picture of the great benefits derived from UNRRA and American Aid, and of the magnitude of the work accomplished in so short a period of time.

Not only has the port been physically rehabilitated in spite of high production costs, occasioned it appears by labour irregularities and other unorthodox practices, but further accomplishments must also be placed to the credit of the Port Authority. These include the establishment of an entirely new system of allocation and payment of port labour; new and simple tariffs of stevedoring and port handling rates; regulations concerning the operating of lighters, tugs and trucks; a new accounting system; and finally, the unification and control of all factors connected with the handling of goods in the port.

It is reported that the present port operation costs have been reduced by nearly 50% compared with two years ago. It is also claimed that the port now rivals all its competitors in the speed of cargo handling, safety of merchandise and economy in working costs.

All the reconstruction and reorganisation work was entrusted to Dr. Milissis, supported by Rear Admiral Bouzanis, General Manager of the Port Organisation, and General Kells of the U.S. Army. They and all members of their staff are to be congratulated upon bringing a difficult and arduous task to a successful conclusion.

Dock Labour Problems.

Reference was made in our October issue to the growing number of registered dock workers at United Kingdom ports for whom no employment is available. Because of this the National Dock Labour Board found it necessary to increase the rate of percentage payments on the gross wages paid by registered employers to 22½ per cent. in order that the guaranteed weekly wage might be maintained. Under the National Dock Labour Board scheme registered dock workers for whom there is no work available are entitled to a guaranteed minimum wage of £4 8s. a week, provided they prove attendance at their calling-on place for eleven half days a week. This money has to be found by employers of dock labour and with about one-fifth of the total number of registered workers now surplus to the average daily requirements a heavy burden has been placed on the industry, which in turn adds to production costs at a time when it is becoming more difficult to compete in world markets.

For some time past it has become apparent that something would have to be done to alleviate the situation. The Chairman of the London Wharfingers' Labour Committee, in a letter to "The Times" made the suggestion that each port should be responsible for financing its own dock labour force. This, however, would not solve the question on a national basis. As another correspondent to "The Times" points out, the docks' industry subsidises the national unemployment fund in so far as a registered dock worker for whom there is no work does not draw unemployment benefit but is paid the minimum wage by proving attendance. No other industry has to pay unemployment benefits out of its own funds and it would be only equitable if the Government would relieve the National Dock Labour Board of this part of its obligations

On 4th December the Minister of Labour and National Service in answer to a question put in the House of Commons announced that the National Dock Labour Board had come to the conclusion that it was essential to take steps to bring the size of the register of dock workers more closely into line with future trade prospects and proceeded to give details of the scheme. Simultaneously the National Dock Labour Board, who had exchanged views with the Minister and also had consulted with the National Joint Council for the Port Transport Industry, issued this scheme which is based on the assumption that there will be no great improvement in the present level of trade for some time to come.

Briefly, the scheme provides for temporary release from the main register on a voluntary basis. The National Dock Labour Board would insure that those who accepted voluntary release would be able to return to the dock industry. The number of men to be freed in each area will be decided by the Board. At present is should be noted, there is no work for 20.7 per cent. of those registered compared with 7.7 per cent. a year ago. Under the scheme the Local Board may grant immediate temporary release to a dock worker on condition that his name is placed on the dormant register. If his services are required next year he will be given the opportunity of returning to the live register. If, however, he elects to remain in alternative employment next year he may still retain his name on the dormant register. The Local Board may recall him at any time during 1954 but if he fails to return within six weeks of his recall his name will be removed from the register. A dock worker still on the dormant list

Editorial Comments—continued

on 1st January 1955 may, on application, be re-instated forthwith on the live register.

Should all the unions concerned accept the scheme, it will still remain to be seen whether sufficient dock workers will volunteer for release to reduce the non-employed surplus to a reasonable margin. To older men the £4 8s. a week is likely to be a more attractive proposition than problematical work in another industry with National Unemployment benefit or the Old Age Pension as the only alternatives.

From the prevailing unsatisfactory trends in the industry, it is apparent that, while the National Dock Labour Board is well able to deal with normal fluctuations of work, its present organisation is insufficiently flexible to meet a trade recession without imposing prohibitive costs on the employers. The problem, therefore, is how to make its functions more elastic without arousing the resentment of the men and reviving the old spectre of casual labour. The suggested voluntary scheme deserves a trial, but if it fails, some other way must be found to bring the number of dock workers on the register more into line with the current volume of work, until such times as a greater turnover of world trade can be assured.

The Use of Pallets at Ports.

On a following page, will be found the first of two articles dealing with " Pallets in the Port Industry " and discussing the use of pallets as handling tools. At one of London's docks an export berth has been completely mechanised by the Port Authority, so that manual handling has been practically eliminated. Mobile cranes, fork lift trucks and pallets have been provided and by these means goods for export are unloaded from road or rail vehicle, conveyed into shed and piled, and later taken to the ship's side and lifted aboard.

The second article, which will be printed in the January issue, will deal with pallets as " permanent " parts of palletised unit-loads of goods. It will examine the question of international traffic in palletised units—an important factor in the development of which is standardisation. In this connection, a three day's meeting was held in London early this month to consider framing international standards for pallets. Delegations from many nations attended, that from Great Britain including representatives of the Dock and Harbour Authorities' Association and the British Council of Shipping.

There is no doubt that important savings of time and money could result from this method of transporting goods. At present, however, goods in unit loads form only a small percentage of short sea traffic; in ocean-going traffic they are virtually non-existent.

Despite the apparent inducements, the extension of the unit load method appears to be fraught with many difficulties. These will, no doubt, be overcome in the course of time, but before they can be resolved successfully, international co-operation in disseminating the latest information and ideas is essential.

Topical Notes

American Association of Port Authorities.

At the 41st annual convention of the American Association of Port Authorities, held recently at Savannah, Dr. M. D. Kinsella, a member of the Toronto Board of Harbour Commissioners, was elected president for the ensuing year.

Mr. Warren D. Lamport, managing director of the Port of Seattle, General W. F. Heavey, general manager of the Port of Houston, and Mr. D. C. Nevins, manager of the Camden Marine Terminals, were elected as vice-presidents, and Mr. Paul A. Amundsen, of Washington, D.C., was reappointed as secretary-treasurer.

The meeting which lasted three days, was attended by port managers and officials from the leading harbours in the United States and 25 foreign countries, who voted approval of a series of resolutions calling on the association's committee on national defence to confer with U.S. Coast Guard officials in developing a better system for the issue of port security cards to terminal employees. It was also recommended that the appropriate Government agencies should take steps to ensure that ports of entry have the same standards of port security for crews of foreign vessels as for American personnel.

One point of outstanding interest was raised by Mr. Henry W. Sweet, the outgoing president, when he urged the members to continue to press for a free hand in the management of port terminals, without political or other interference from state and local bodies.

New Port Facilities at Savannah.

The formal opening of the Savannah State Docks and Warehouse System of the Georgia Port Authority took place on November 11th last, the ceremonies being attended by port managers and officials from leading ports of 25 nations.

The new facilities include a concrete wharf 80-ft. in width and 2,047-ft. in length along the channel of the Savannah river. This marginal wharf will provide berthing space for four Liberty ships and is served by three warehouses so arranged that the wharf can also be operated as three separate berths, each approximately 630-ft. in length. These will accommodate any of the larger type cargo carriers now being constructed.

All the warehouses are 165-ft. wide; two of them are 450-ft. long, and provide approximately 74,000 sq. ft. of covered storage space, and the third is 360-ft. long and has 59,000 sq. ft. of storage space. All have concrete floors and are fitted with modern lighting facilities for night work.

Truck loading docks are provided at each end of the first two warehouses and at the south end of the third, and a 180-ft. wide space between them leaves ample room for a road joining the main road to the wharf.

Radio Telephone System at Southampton.

Further proposals towards the establishment at Southampton of a port control and information service were adopted at a recent meeting of the Southampton Harbour Board. A feature of the service will be a radio telephone system providing communication between important shore points and all ships entering or leaving the port. Its operation through the pilotage service has been discussed with Trinity House, which has promised to co-operate.

It is reported that two radio-equipped launches will patrol Southampton Water when the service is in operation, and that the control and information service will be based on the Board's new control station on top of Calshot Castle, which gives a commanding view of the port and its entrances. The Board's offices, the control station, and important points such as the docks and Esso terminal at Fawley, and the Shell Mex jetty at Hamble, have already been linked by direct telephone.

Consideration will also be given to the provision of a visual signalling system from the Calshot Control Station, to be worked in conjunction with the radio telephone system.

New Tanker Discharge Facility.

To speed the discharge and turn-round of tankers, a 16-in. diameter pipe line has been laid out to sea from the Shell Petroleum Company's oil storage installation at St. Vincent, Cape Verde Islands.

The value of the line was immediately made clear when the Shell-chartered tanker Hektoria, first to use the new facilities, took only 30 hours to discharge her cargo of 12,814 tons of oil, as against the average time of four to five days when using the old method of discharging into barges. Even this discharge and turn-round time has been reduced with experience.

The full length of the pipe, of 4,300-ft., was pre-fabricated on shore, and the actual launching operation was performed in 40 minutes. First of all the line was moved on rollers, across the wide shifting sands of the beach and 50 yards into the sea, by tractor, with assistance by men with rope blocks. Then a tug and a mooring barge took over until the last 100 yards when the barge completed the tow.

When the sea end of the line was exactly at the right point, the float was cast adrift and the sinking plug removed; the pipe then submerged steadily at about 20-ft. per minute. The next task was the laying by divers of 10 concrete block anchors on the sea-bed at intervals along the line. The buoy moorings were then installed and the pipe cleared of water and re-filled with heavy oil for preliminary tests.

The Port of Piraeus (Athens)

Rehabilitation of Historic Aegean Harbour

By J. ANDRONICOS, C.E.
Manager of Technical Services and Acting General Manager Port of Piraeus Authority.

Historical.

In "The Dock and Harbour Authority" issue of March 1931 there appeared an article on the Port of Piraeus giving a historical and geographic description from the point of view of transportation, statistics of shipping and harbour works.

It was pointed out at the time the necessity for co-ordination of the various services of the Authority for the purpose of bringing order in the operations of the port.

Since then and until the second World War, notable improvements had taken place in the installations of this major Port of Greece. Construction of harbour works was carried out, i.e. quay walls, warehouses, silos etc., as well as the acquisition of mechanical equipment.

The pre-war installations of the port may be summarized as follows: modern quays constructed with water depths of:

10 metres	1700	linear metres
9 metres	600	linear metres
8 metres	400	linear metres
3 metres	665	linear metres

Old quay walls 3,000 linear metres with depths of water varying between —3 m. to —8 m.

Transit sheds and bonded warehouses equipped with lifts and other conveniences of a floor space of 47,000 sq. metres. Storage capacity 86,000 tons of goods. Grain silos, equipped with a pneumatic suction system discharging 300 tons of grain per hour—storage capacity 20,000 tons.

Two graving docks, the largest of which could accommodate ships up to 12,000 tons and the smaller up to 4,500 tons. These docks were equipped with two electric two-ton cranes and with one 12-ton crane, and a pump well of 1,000 h.p.

One privately-owned patent slip with a machine shop for ships up to 2,500 tons.

Two bridge cranes for the discharge of coal of a span of 105 m. and a discharging rate per hour of 150 tons each, located at quay AB.

Seventeen electric 2-ton cranes, and four electric 5-ton cranes located on the new quay walls, for discharging goods from ships.

Telephone, electricity and water supply networks.

Complete road system and outdoor storage spaces.

Railway tracks of standard gauge for the State railways and some narrow gauge tracks for the Peloponnesus railways.

The Piraeus Port Organisation was founded in 1931 succeeding the Piraeus Port Committee. Among the tasks assigned to the new organisation were the maintenance and extension of the port's installations and equipment together with the carrying out of loading and discharging operations. In this way order and co-ordination was brought to all port activities.

At the same time the jurisdiction of the Piraeus Port Authority had been extended to cover the nearby bay of St. George as well as the coast from the small harbour of Munichia to Perama, including the bay of Ambelaki in the island of Salamis.

In pre-war days there was a progressive development of the traffic of the port, for example the number and tonnage of ships entering the port rose from 12,000 and 6,800,000 in 1931 to 13,000 and 7,400,000 in 1939, respectively. While import and export tonnages respectively rose from 1,974,000 and 697,000 in 1931 to 2,400,000 and 1,000,000 in 1938.

After the outbreak of the second World War there occurred a slump in the traffic of the port and any further improvements had to be suspended. When, in 1941, Greece was occupied by the forces of the Axis there was a complete standstill in the activities of the port which was used thereafter for military purposes only.

In the course of the war the Port of Piraeus suffered severe damage, at first from the explosion of a steamer loaded with ammunition which was bombed by German planes, then by Allied aircraft during the German occupation and finally by the utterly defeated and retreating Germans.

The latter having systematically mined the new quay walls, piers, graving docks and port machinery, blew them up the day they left, destroying in this manner, in a few hours, what the Greek people had built up by hard work during long decades and at great sacrifice.

The damage done to the port may be summarized as follows: Partial destruction of the piers, wrecking of quay walls, demolishing of graving docks, damage in varying degrees to port structures, roads and railway trucks, wrecking of the port's network of lighting and its water supply, and finally, the wholesale destruction of all the mechanical equipment except three cranes. Also, various vessels were sunk in the port either from bombardments or by the Germans.

Technical.

As soon as possible after the liberation (November 1944), the technical services of the Port of Piraeus Organisation (O.L.P.) tackled the work of collecting and transporting the waste materials from the ruins and of the repair of damages.

This work was, of course, a tremendous achievement, exceedingly difficult and requiring considerable financial and technical means, both of which were lacking; it therefore had to be carried out by stages.

Thus, from the very beginning, and with the help of the British Corps of Royal Engineers, the breakwaters that protected the port from the rough seas were hastily repaired, and later on began also the temporary repair of the quays and of the electricity, watering and telephone networks, as well as of the road network of the port.

The Communist rebellion of December 1944 caused the interruption of these works, and, after it was quelled, work was resumed again, but always within the limited financial possibilities of the O.L.P. Notwithstanding these difficulties, and with the assistance of the Greek Government, who appropriated special funds to this effect, many items of reconstruction work were completed, firstly the permanent repair of the breakwaters, on one of which a new signal station was erected, was put in hand, then with the assistance of the British Corps of Royal Engineers, semi-permanent repairs were carried out (with concrete slabs) on part of the quays, thus creating five places for berthing of big ships alongside the quays. Then followed the repairs to other quay walls, piers, buildings, roads, railway tracks as well as to lighting and water supply installations.

UNRRA gave to the port for its immediate requirements some caterpillar cranes and a 15-ton floating crane. By contributions of the Athens and Piraeus Chambers of Commerce repairs and extensions were made to three harbour sheds. Custom house control rooms, new offices and warehouses were built by a special Committee set up for the purpose. The State Railways and the Peloponnesus Railway Company made sundry repairs and additions to the network of their railway tracks, and finally, a State-controlled salvaging organisation cleared the port of most of the wrecks.

However, the most important contribution to the rehabilitation of the Port of Piraeus were the works carried out by the American Aid.

The American Mission, on the basis of the Agreement drawn up between the Government of the United States and of Greece, entrusted the execution of these works to the American concern of Messrs Steers-Grove; these works were carried out from September 1948 to January 1949, under the supervision of the Body of American Engineers, and in close co-operation with the Technical Services of the Port of Piraeus Authority.

The following are the works carried out by the Americans:

The two dry-docks were repaired.

A section of quays near the dry-docks, and other quays extending for a length of about two kilometres were repaired.

New artificial blocks had to be used in the reconstruction of the quay walls in the place of the old blocks which had been condemned on account of severe damage. A new quay wall had to be constructed in front of the old one at Z—H and, taking advantage of this opportunity the harbour sheds have been extended at that place towards the water front.

A large fish pier is also being constructed with American Aid funds in the Port of

The Port of Piraeus (Athens)—continued

Piraeus, at the place known as Niodochi where lighters are moored. The effects of this new harbour work upon the well-being of the inhabitants of Athens, Piraeus and the hinterland need not be emphasised. Good wholesome food will become available to them in abundant quantities and at moderate prices.

The Americans laid out for these works a sum of 3,700,000 dollars and of 33 billion drachmas (according to a statement made to the Press).

But besides these constructions, the American Aid funds contributed to a considerable extent to the rehabilitation of the mechanical equipment of the Port of Piraeus with the following items:

Various small waggons for the conveyance and stacking of goods ; machinery of the grain elevators; 13 electric cranes of a capacity of from 3 to 15 tons; 6 electric 6-ton cranes; 4 electric 3-ton cranes; as well as the whole machinery for the dry-docks' pumping station. Also, out of German War Reparations a bridge crane for unloading coal was allotted to Piraeus.

A more detailed description of the mechanical equipment of the port is given later by the Chief Mechanical Engineer, Mr. E. Perrakis.

Along with the construction of the above works, the Piraeus Port Authority spared no effort to continue the development of the port within the limits of its financial resources. The work included the provision of new quay walls, improvement of the sewerage system, new warehouses and office buildings, fire stations at various points of the port, new water supply network, new repair shops, various substations for power transmission, installation of electric lighting, telephones, floating piers for berthing ships, dredging and large-scale clearing of the port.

Thus, today, the installations, harbour works and mechanical equipment exceed the pre-war totals and may be summarized as follows:

Projects completed with American Aid funds:

10 metres	1200	linear metres
9 metres	600	linear metres
8 metres	200	linear metres
3 metres	60	linear metres
Total	2060	linear metres

Sundry repairs made to the two graving docks.

Projects completed by the Piraeus Port Authority:

Quay walls in depth of —8 m.	2,250	linear metres
Quay walls repaired in a semi-permanent form	2,000	linear metres
Piers repaired	800	linear metres
Buildings and warehouses repaired	40,000	sq. metres
New buildings and warehouses repaired	20,000	sq. metres
Roads repaired	50,000	sq. metres
New roads built	20,000	sq. metres
New open harbour spaces shaped	55,000	sq. metres
Existing open harbour spaces	120,000	sq. metres
Storage capacity of warehouse	125,000	tons
Storage capacity of Grain Silos	20,000	tons

Traffic of the Port.

Since the liberation of the country, in November 1944, the traffic through the port has been on the increase and has now reached a higher level than in pre-war days.

In order to obtain some idea of the present traffic of the port below are given certain statistical tables for the year 1951.

IMPORTS FROM ABROAD.	Tons	Percentage
Liquid fuel	1,025,906	12.10
Wheat	379,472	15.57
Coal	181,394	7.44
Miscellaneous foodstuffs	154,430	6.34
Chemical fertilizers	144,405	5.93
Iron and iron wares	91,577	3.76
Sugar	81,125	3.33
Timber and wooden articles	58,189	2.39
Chemical and pharmaceutical products	51,181	2.10
Machinery	40,845	1.68
Paper and raw material of ditto	27,219	1.12
Textile industry products and raw material	12,905	0.53
Cattle	10,792	0.44
Automobile and accessories	6,754	0.28
Hides and leather articles	3,223	0.13
Sundries	167,253	6.86
Total	2,436,670	100.00

Dry Dock Area, after Reconstruction.

Goods Exported from the Port of Piraeus during 1951 according to Countries of Destination.

Countries	Tons of goods	Percentage
Holland	15,215	32.56
Turkey	9,168	19.62
Italy	3,727	7.98
United Kingdom	2,583	5.53
Germany	2,511	5.37
U.S.A.	2,485	5.32
France	2,404	5.14
Other Countries	8,636	18.48
Total	46,729	100.00

THE MECHANICAL EQUIPMENT OF THE PORT OF PIRAEUS

The mechanical equipment of the Port of Piraeus before the outbreak of the Second World War consisted of the following machinery: 17 electric wharf cranes of 2 tons capacity travelling on rails and 4 of 5 tons capacity, also 2 electric fixed wharf cranes of 2 tons capacity. Two bridge cranes with a span of 105 metres for discharging coal at the rate of 150 tons per hour. Pneumatic suction grain elevators lifting 300 tons of grain per hour. Two graving docks accommodating ships up to 10,000 and 4,000 tons with a pump well equipped with two pairs of pumps of 10,000 cub. metres capacity per hour. One travelling crane on rails of 12 tons capacity at 25 metres and two cranes of 3 tons capacity at 20 metres with fixed booms.

The whole of the above equipment except one of the 17 cranes was destroyed during the war.

After intensive work with American Aid, the aforesaid equipment has been replaced as follows:

Wharf Cranes.

By salvaging parts of the destroyed cranes four cranes of 2 tons capacity have been restored and put in operation. In addition 15 electric cranes travelling on rails of 1.50 and 3 tons capacity with changeable booms 7/20 metres have been acquired. They were manufactured by Demag (Germany) and Stothert and Pitt (England). Also six electric cranes of the same type, of 3 to 6 tons capacity at 7.60/20 metres manufactured by Cowans Sheldon and Co., of Carlisle, England.

Grain Elevators.

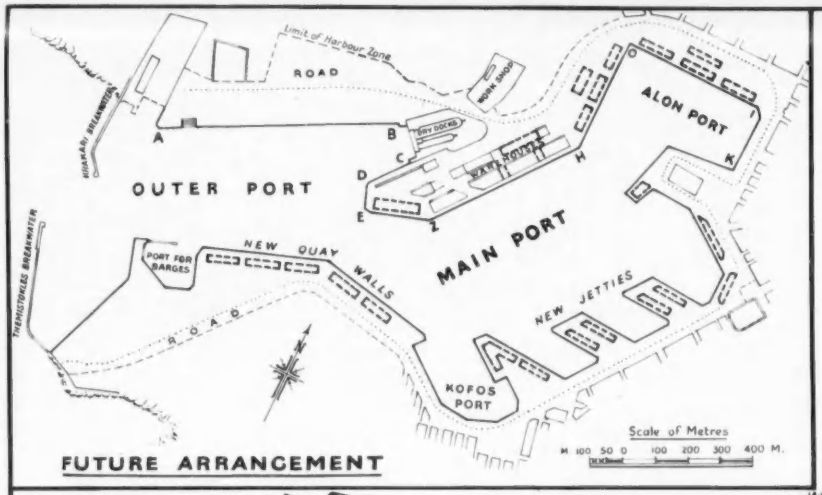
Pneumatic suction grain elevators of an output of 320 tons per hour have been installed. They were made by Hartmann, Germany.

The vacuum pumps are installed two on each of the portals coupled directly to the electric motors. Thus each pair of pumps and motor has a suction capacity of about 80 tons of grain per hour.

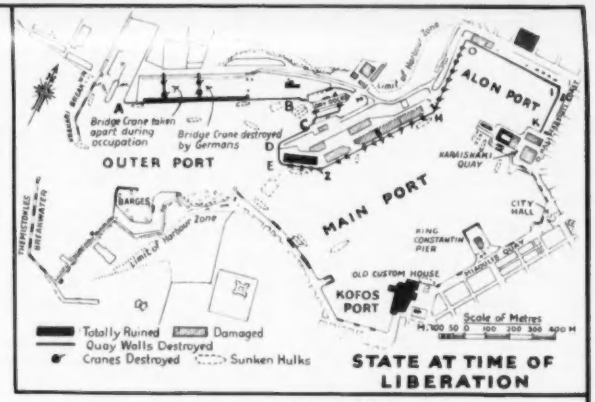
Graving Docks.

The installations of the graving docks have been completely renovated. The new pump well consists of two pairs of vertical pumps,

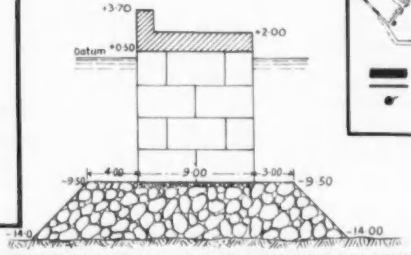
PORT OF PIRAEUS



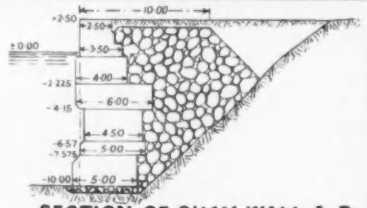
FUTURE ARRANGEMENT



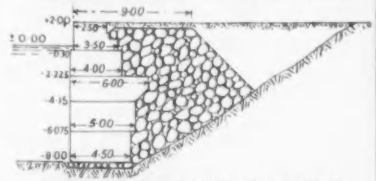
STATE AT TIME OF LIBERATION



SECTION OF THEMISTOKLES BREAKWATER



SECTION OF QUAY WALL A.B.



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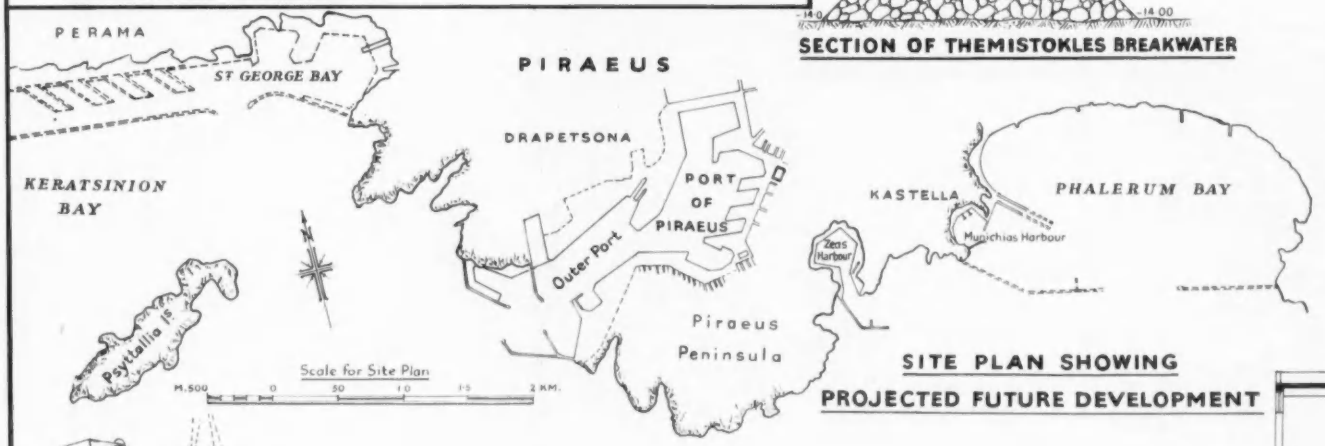
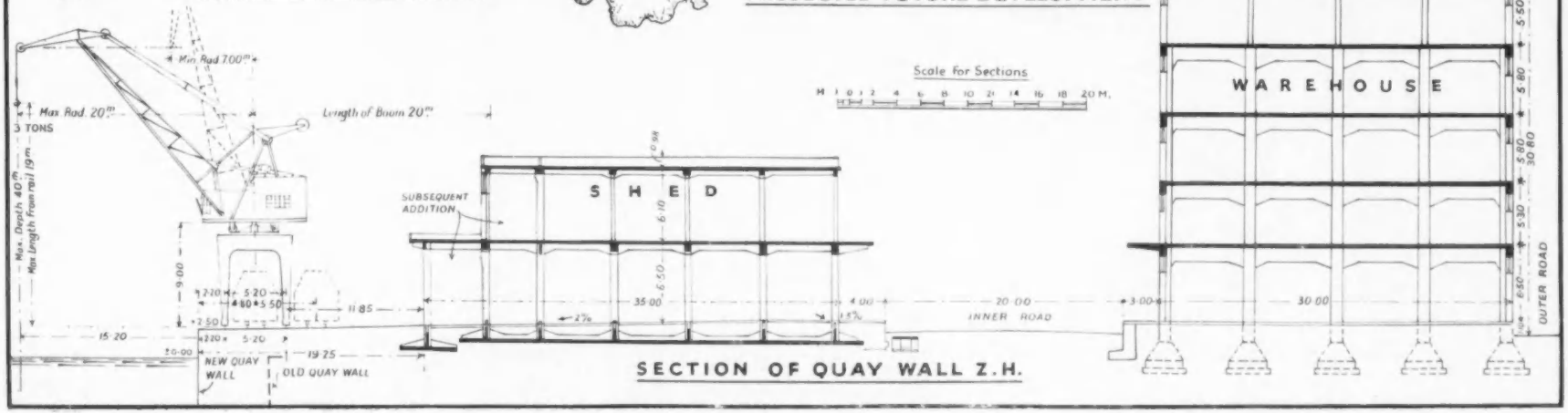
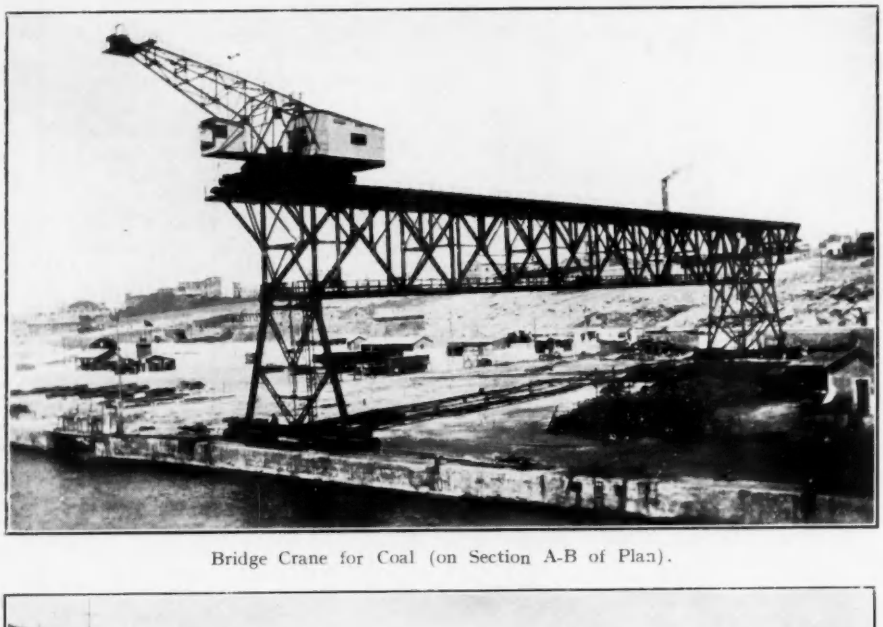


SITE PLAN SHOWING
PROJECTED FUTURE DEVELOPMENT



SECTION OF QUAY WALL Z.H.

The Port of Piraeus (Athens)—continued



Bridge Crane for Coal (on Section A-B of Plan).

Reconstruction of Free Zone. Concrete Blocks on Float at Z-H Quay Wall.

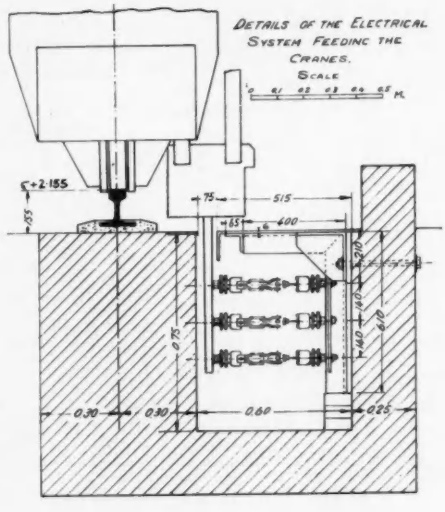
each pair having an output per hour of 10,000 cubic metres. The General Electric motors operate with 6600 volts 50 cycles current and are started automatically by a simple turn of a switch by the interposition of a system of switches and resistances operating under a 120 volt direct current produced by a series of batteries.

A 15-ton electric crane with a 12.5/25 metre boom, has been installed within the area of the graving docks and two cranes of 1.5/3 tons capacity with a 7/20 metre boom.

These docks have also been equipped with new capstans, a direct current generator and floodlights supply lighting equal to daylight.

Handling of Coal Cargoes.

A bridge crane, built in 1939, allotted to the port out of German War Reparations will be put into operation shortly. This has a span of 87 metres and a longitudinal travel of



105 metres, with a grab capacity of 5 tons and a total output of 80 tons per hour.

Besides the above electrically operated equipment the port has been equipped with 34 mobile cranes of various types and capacity ranging from 2 to 10 tons, and with 45 fork lift trucks of 2,000 to 5,000 lbs. lifting capacity. Two floating slewing cranes of 15 and 30 tons capacity with changeable booms and a number of tugs have been added to the port's equipment.

All of the above machinery and apparatus are the property of the Port Authority. There are also some State and privately owned powerful tugs and diesel electric 60-ton cranes and sheer legs of 30-70 tons capacity.

Electric Power Installations.

For the operation of the Authority's machinery a three phase 380 volt 50 cycles current is used except in the pump well of the graving docks, where the motors of the two large pumps are fed with high tension 6600 volt current directly supplied from the power-house of the Athens & Piraeus Electricity Company.

The 380 volt electric current is obtained from five sub-stations where the 6600 volt high tension current of the city's network is transformed. These sub-stations, besides the usual instruments (transformers, switches, etc.) are equipped with condensers of appropriate capacity by which it has been made possible to improve the power factor of the port's installations from 0.4—0.6 to 0.75—0.9 with a corresponding reduction of the required power for the operation of the cranes.

The wharf cranes are travelling on a continuous track of about 1100 metres, along which there is an underground power supply line fed at six different points by the transformer sub-station. The power for each crane is collected by the Stromag Safety System, the opening for the passing of the power collector being protected by a steel strip. The system despite the length of the line and the two curves at Z and H points is working perfectly.

The Port of Piraeus Authority.

The Port of Piraeus Authority is a statutory body and is solely responsible for the administration of the Port of Piraeus and of the Piraeus Free Zone. Its duties are:—

The construction and maintenance of the port's installations, the regulation of anchorage and berthing of ships, sanitation and Fire Service, the performance of loading and discharging operations by its own personnel and labourers, accepting delivery and storing all discharged goods. It also establishes the tariffs of rates for handling cargoes in the port, fixing the dues for storage in the areas controlled by the Authority. It levies dues on vessels entering the port, on berthing of ships and on vessels at swinging berths. It collects dues for the use made of piers and quays and on passengers and goods passing through the port; also on goods transhipped within the port.

The Port of Piraeus (Athens)—continued

Under the approval of the Council of Ministers, it may concede the exploitation of certain open spaces in the port to third parties and may contract loans for the execution of projected works in the port which may be guaranteed by the State.

Civilian goods may be placed in the Free Zone of Piraeus by traders, as also goods in transit and in bonded storage.

The Authority also disposes of special areas for the storage of inflammable and explosive goods.

The discharge of liquid fuel is made directly at the installations of the oil companies, most of them being internationally known and who have had for years up-to-date installations in the port for this purpose.

The Port of Piraeus Authority is governed at present by a Board of Directors in which are represented the State, commercial interests of the country and port labour. The chief executive officer is the General Manager.

The revenues of the Authority are derived from port dues, taxes and charges, cargo handling dues, storage charges and other fees for the use of port installations and of the mechanical handling facilities.

There are about 2,000 registered permanent labourers (stevedores, dockers, coal heavers, grain handlers, porters and workmen on sailing vessels).

Whenever the number of registered labourers is insufficient to handle the day's work casual labourers are hired for that day only.

Labourers' wages for a continuous six-hour work have been fixed as follows:—

1. Drs. 60,000 per day for coal heavers and grain handlers.
2. Drs. 55,000 per day for labourers working on sailing vessels.
3. Drs. 50,000 per day for dock labourers and porters.
4. Drs. 40,000 per day for casual labourers.

There is also piecework for certain goods calculated on the tonnage output and remunerated from 600 to 1.100 Drachmas per ton per labourer according to the goods handled by each gang.

The regular work is performed by two shifts, from 8 to 14 (for the morning shift) and from 14 to 20 (for the afternoon shift). Continuation of work after these hours is considered as extra work (overtime).

Dues.

For the purpose of assessing cargo handling dues, goods are classified under two general categories:—

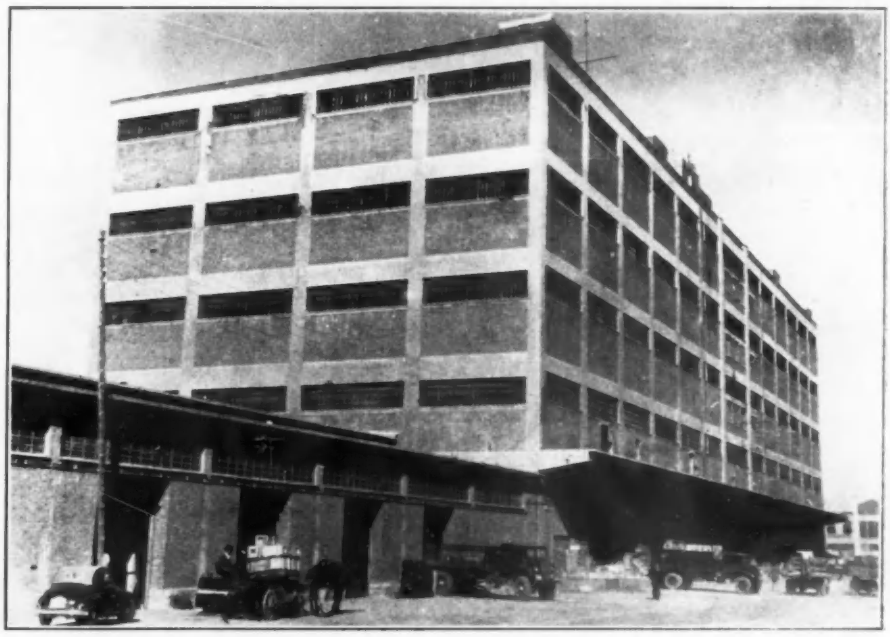
Bagged goods,

All other general goods.

Payment of discharging and porterage dues that are borne by the consignee is made at the time of delivery of the goods or at the time of transhipment, as the case may be. Stevedoring is charged to the carrier (the ship), whereas all other handling charges from alongside the ship, porterage and storage are charged to the goods (the consignee).

However, if the goods are shipped under FIO terms, stevedoring and any extras are charged to the consignee, as well as all extras incurred during the discharge of goods shipped under liner terms.

Reconstructed Free Zone Waterfront, showing Quay, Portal Cranes, type of Shed, and Vehicular Traffic working on wide apron.



Repaired Free Zone Warehouse at rear of Two-storied Transit Shed seen illustrated above.

Handling dues per ton of goods of foreign origin or destination.

Categories	Stevedoring	From alongside to quay or warehouse	Porterage	Agency fees
	Drs.	Drs.	Drs.	Drs
Bagged goods	12,000	22,000	22,000	3,000
General Cargo	15,000	30,000	30,000	5,000
Refrigerated ships with engine running	26,000	30,000	30,000	5,000
Timber:				
(a) White M3	11,000	15,000	15,000	800
(b) Red M3	15,000	20,000	20,000	800

Note.—If lighters should be used during loading or discharging operations no other charge beyond the above is made except towage outside the port.

Towage is compulsory for ships of the Mercantile Marine of a total gross tonnage of 1,000 tons and over, incoming and outgoing and moving inside the port. Towage rates now in force are as follows:—

Gross tonnage	Drachmas
1,001 to 2,500 tons	300,000
2,501 to 4,000 tons	450,000
4,001 to 7,000 tons	650,000
7,001 to 10,000 tons	800,000
10,001 tons and over	1,000,000

For towage at non working hours the rates are increased by 30%.

Vessels calling at Piraeus within the port area pay dues; berthing dues if berthed alongside a quay or pier; and dues when at

The Port of Piraeus (Athens)—continued

layby moorings, if they remain idle in the central port, out port or at St. George Bay without undergoing repairs or loading and discharging cargo. The scales are as follows:

A.—Dues on Ships.

1. Ships from foreign ports :
   (a) From 1 to 10,000 tons, Drs. 50.000 to 700.000.
   (b) Over 10,000 tons, per ton Drs. 70.
2. Ships of the Mercantile Marine (cargo boats) :
   (a) From 1 to 10,000 tons, Drs. 50.000 to 900.000.
   (b) Over 10,000 tons, per ton Drs. 70.

B.—Berthing Dues.

Ships from foreign or home ports, passenger or cargo boats :

(a) For each of the first ten days, per linear foot of occupied quay wall, Drs. 200.
(b) For each day beyond the 10th day, per foot Drs. 400.

C.—Dues on Vessels at Layby Moorings.

Every ship or boat remaining idle in the central port, the Alon Harbour, the outer port or St. George Bay, pay dues as follows:

(a) For the first month, Drs. 50 per day for each ton of her total gross tonnage.
(b) For any period beyond the first month, Drs. 100 per day and per ton.

Forecast for the Future.

The present administration of the Port of Piraeus Authority is sparing no effort to promote the growth of the port in every way and make profitable its operation.

The Technical Services of the Authority have drawn up complete technical studies of a new arrangement of the port and of its territory.

These projects will help to put the port on an entirely productive basis and the programme in question, when completed, will represent an outlay of some 750 billion Drachmas, say U.S. Dollars 50,000.000.

It must be understood, however, that a programme of such magnitude cannot be carried out all at once, so it will be necessary to proceed to its execution by degrees. A technical study has, therefore, been prepared for the more urgent projects for an amount of 15,000,000 dollars with a provision of having the works financed by the successful bidder at an international competitive tender to be held for this purpose.

The loan in question will be paid out of a sinking fund to be formed by setting aside part of the Authority's resources.

This programme is under consideration by the Port of Piraeus Authority to be put into effect as soon as circumstances will permit and the port will thus assume the position which it deserves.

Safety of Life at Sea

New Rules for Merchant Ships

The International Convention for the Safety of Life at Sea, which was drawn up in London in 1948, came into force last month. Simultaneously, new safety rules made by the Minister of Transport under the Merchant Shipping (Safety Convention) Act, 1949, was brought into operation to give effect to the Convention.

The rules are the outcome of many months of discussion between the Ministry and representatives of British shipowners, shipbuilders, masters, and men. They apply to United Kingdom ships and in many cases to other ships while in United Kingdom ports.

One of the most important requirements introduced by the 1948 Convention and adopted in the 1949 Act is that in future it will be necessary for a cargo ship of 500 or more gross tons, engaged in international voyages, to undergo survey at least once in 24 months and to be in possession of a new international certificate, the Safety Equipment Certificate. This certificate will cover the vessel's life-saving appliances, fire appliances, light and sound signals, and distress signals.

Under the new Act, which has now come into force, new cargo ships must also carry stability information for the guidance of the master in loading and ballasting. Previously this information was required to be carried by passenger ships only.

The main differences between the old and the new British rules are as follows:—

Construction Rules.—These rules cover the hull and machinery of all classes of passenger ship from the ocean liner to the small seaside pleasure boat carrying more than 12 passengers. Fire precautions are made more stringent. It is also laid down that the electrical installations shall be such that electrically-operated services essential to the safety of the ship and those on board can be maintained in emergency conditions.

Life-Saving Appliances.—Lifeboats which carry more than 60 people must be mechanically propelled and have some means of enabling persons to climb into them from the water. Mechanical hand-propelled lifeboats are now treated as equivalent to motor boats, but larger passenger ships must carry at least two motor boats.

Tankers of 3,000 gross tons and over must have at least four lifeboats. Previously they could have fewer than four if on each side of the ship there were sufficient boats to accommodate all on board. Ships must also carry a dozen parachute distress signals, and lifeboats two parachute signals and six hand flares. Previously numbers were not specified.

Pleasure yachts over 15 tons burden are dealt with in the rules as a special class. They are required to carry a boat or boats capable of accommodating all on board and also sufficient buoyant apparatus or lifebuoys to support all on board. They must have at least two lifebuoys; in addition they must have one lifejacket for each person.

Fire Appliances.—These rules have been reviewed and brought into line with modern practice. Cargo ships of 1,000 gross tons and over must now have on board two fire pumps. Previously this rule applied only to ships of 2,000 gross tons and over. Special provision is made for pleasure yachts exceeding 15 tons burden, which must have a pump and fire hose, fire buckets, and portable fire extinguishers.

Radio Rules.—Continuous watch must be kept on the " distress " frequency either by a radio officer, or by auto-alarm, on all ships of 1,600 gross tons and over. All cargo ships between 500 and 1,600 gross tons are required to be fitted with either radiotelegraphy or radiotelephony, and to keep a distress watch for eight hours a day. The carrying of a direction-finder by which ships can determine their own position and the position of vessels in distress is made compulsory in all ships of 1,600 gross tons and over, but a ship of less than 5,000 gross tons will not be required to comply before November 19th, 1954.

Grain Rules.—The 1949 Act places on owners and masters of all United Kingdom ships wherever they are loaded the obligation to take all necessary and reasonable steps to prevent grain cargoes from shifting. The rules prescribe the particular precautions all grain ships loading in U.K. ports or entering them when so loaded must take. Previously only ships loading in North America or in the Mediterranean and Black Seas were covered by these rules. Less stringent precautions are required in ships trading within Home Trade limits (Elbe to Brest).

Dangerous Goods Rules.—These rules set out the general principles governing the carriage of dangerous goods by sea. The detailed requirements for the packing, marking and stowage of dangerous goods in ships in United Kingdom ports are set out in the Report of the Departmental Committee on the Carriage of Dangerous Goods in Ships, published early this year.

Pilot-ladders Rules. — Ships on international voyages and those in the coasting trade which employ pilots must carry suitable pilot ladders, and it must be possible to illuminate them at night.

Copies of the Rules can be obtained from H.M. Stationery Office.

Under the Convention, other contracting Governments are also pledged to take whatever action is necessary to give effect to the requirements of the Convention. So far 19 countries have deposited acceptances with the United Kingdom Government. These countries between them own 70 million gross tons of merchant shipping, or four-fifths of the total world tonnage.

The new Convention replaces that of 1929; H.M. Government have denounced the 1929 Convention and the denunciation will become effective in November, 1953. It is expected that most of the other Governments which are parties to the 1929 Convention and which have accepted that of 1948, will take similar action.

Correspondence

Handling of Cargo at Ports

To the Editor of *The Dock and Harbour Authority.*

Dear Sir,

I was particularly interested in the comments of Dr. Paul Liemdorfer in the September, 1952, issue of your publication, relative to the comparative merits of handling cargo in European and U.S.A. ports.

While it is true that the facilities of certain United States ports were constructed and are operated by railroad companies, this does not hold for the majority of our harbours. For instance, the railroads own very few of the 200 odd steamship piers in New York Harbour used for the docking of ocean-going vessels. The same is true of San Franciso, Los Angeles, New Orleans, Houston and Philadelphia. It is a fact that at Baltimore, Hampton Roads and Boston the piers are either owned or operated by the railroads. However, it is a safe guess that the major parts of general cargo and merchandise freight handled at United States ports is discharged or loaded at other than railroad owned or operated facilities.

From my knowledge of operations on both continents, I agree with the comments pertaining to the development and use of inland navigation. While **packaged freight and general merchandise** is moved in large volume by inland waterway carriers in Europe, this is not true of the United States, where approximately 300,000,000 tons of **bulk cargoes** were transported on the 28,000 miles of inland waterways of this country in 1950. Rarely do any of the U.S. inland waterway carriers ship other than full barge loads of bulk commodities, such as coal, petroleum, ores, grain, chemicals, etc. They carry little or no merchandise freight. There is some movement of iron and steel, and in recent years there has been a considerable increase in the shipment of unboxed automobiles for domestic destinations by double-decked river barges. The capacity of these barges for bulk commodities ranges all the way from a minimum of 200 to 3,000 tons and they are generally moved in fleets of three or more units propelled by high powered diesel tugs. For the loading and discharging of bulk freight, specialised equipment is provided by the waterfront industrial plant or terminal for inland barges. Rarely, if ever, are such barge facilities provided at ocean-going terminals.

In a study of freight handling at the Port of New York it must be realised that this harbour handles a major part of the United States exports and imports of packaged freight, manufactured articles and high value merchandise. Aside from grain, ore and a few similar commodities, very little bulk cargo is loaded or discharged at New York piers. New York is predominantly a high revenue merchandise port.

At the moment, not a single New York pier is equipped with a dockside crane. The cargo is transferred between the pier and ship's hold by use of Burtoning System, employing ship's gear and a steel cargo mast, which runs down the length of the pier above the transit shed, or ship's gear exclusively. These two systems have been in use in New York Harbour almost since the day of the first steamships. Floating cranes, of which there is a large fleet with capacities up to 300 tons, are used to handle heavy lift shipments, such as locomotives, machinery, railroad cars, etc.

In the final analysis, the merits of a particular system of cargo handling method can only be determined by the efficiency and speed with which the freight is transferred. Such a comparison, however, with the European use of quayside cranes is difficult and can only be determined by a detailed study of both methods.

Such data that has come to hand through the years has not been sufficient to convince the writer that we should make any change in present methods. To the contrary, he is impressed by the huge investment and maintenance cost for the installation and operation of crane equipment Furthermore, the Burtoning System as used in New York Harbour, presents a greater flexibility in the handling of general merchandise and packaged freight, particularly in its co-ordination with the terminal use of mobile mechanical handling equipment, such as fork-lift trucks, tractor-trailer trains and conveyors.

There is also another factor to which very little attention has been given and that is the labour element. European longshoremen have been trained in the use of quayside cranes in the same manner as American longshoremen in the use of the Burtoning System or ship's gear. Any attempt to change either method would undoubtedly result in a sharp decrease in terminal efficiency for a long period of time and probably antagonise the loading gangs. It is unlikely that any terminal would want to experiment in face of this probability.

Yours faithfully,

Port of New York. L. W. BYRNE,
7th November, 1952. Chief, Trade Promotion Division.

To the Editor of *The Dock and Harbour Authority.*

Dear Sir,

In the June/July issues of the "Dock and Harbour Authority," Dr. Ing. Hans Neumann presents a mass of evidence to prove that quayside cranes are the answer to all the problems of cargo handling in European ports.

Within the past few busy years, there has been an uninformed demand for this type of equipment in Australian ports, and it is possible that the casual reader of Dr. Neumann's articles might conclude that the relative lack of these cranes in the Antipodes is concrete evidence that our ports fall far short of modern standards.

Speaking for the Port of Sydney, it can be definitely stated that the paucity of wharf cranes results from the deliberate conviction that their general installation throughout the port would be completely unjustified. The factors that may dictate their use in certain European and U.K. ports are largely non-existent in Sydney and secondly Dr. Neumann's conclusions have little or no applicability to our local conditions.

Sydney wharves, in the main, are built to a pattern of relatively narrow aprons. Barge traffic in this port is negligible in contrast to the proportion of up to 75% of cargo handled in this manner at, for instance, Rotterdam and London. The voluminous rail traffic which Dr. Neumann indicates as a characteristic of Continental ports has no parallel whatsoever here, where only about 2% of the cargo throughput of the port is handled between ship and rail trucks. Again, Sydney has a mean tidal range of only 3.35-ft. so that the handicaps to ship's gear experienced in Continental ports through big changes in water levels between tides are non-existent.

A further point is that, in Sydney, apron and shed floors are all on the one level, with loading platforms on one side only. This absence of a loading platform on the wharf side is consistent with the narrow aprons in use, and can in no wise be regarded as a disadvantage, as it might be under perhaps Continental conditions. Here it is common for trucks to load in sheds direct from stacks or with the aid of mobile cranes or fork lifts.

Making allowance for the differing conditions, it is suggested that Dr. Neumann's theories as to the economies effected in the number of berths and the length of wharfage under given conditions by the use of wharf cranes would have little bearing in Sydney, where the utmost efficiency in the use of wharf premises is secured by higher stacking with mechanical equipment inside sheds and the enforcement of quick deliveries of cargo.

Dr. Neumann's articles failed to touch upon the remarkable efficiency of the modern ship's gear, which to-day is constructed to meet most of the variable conditions which are to be found in the different ports throughout the world.

By and large, however, it is felt that the conditions here differ so widely from those which may satisfy Dr. Neumann's conclusions, that his summary has little applicability to the Port of Sydney. Admittedly the use of shore cranes at times in conjunction with ship's gear could be advantageous. Such use, however, envisages a combination of somewhat ideal circumstances, which would include a large cargo, a clear wharf and full availability of labour. Under normal circumstances, which we have now reverted to, including normal cargoes which rarely exceed 3/4,000 tons, the slight economy in time which might be achieved could not, under any circumstance, be put forward as a justification for the comparatively huge expenditure which would be involved in the general installation of these cranes throughout the port.

Maritime Services Board of New South Wales.
Circular Quay,
Sydney, Australia.

Yours faithfully,
W. H. ROBERTS, B.Ec.
Statistical Officer, Port of Sydney.
24th November, 1952.

Re-construction of Carenage Quay Wall at Dieppe

Novel Application of Prestressed Concrete

By M. DESBAZEILLE*
Ingenieur des Ports et Chaussées.

Summary.

THE following article describes how one of the principal tidal quays at Dieppe has been reconstructed after almost complete destruction during the military operations of 1944. The damaged wall of the quay had been founded on caissons sunk by compressed air and resembled a simple gravity wall. The explosion of a number of German mines displaced and tilted the foundations. These were nevertheless to be re-used, the new wall being solidly anchored in the ground of the back-fill by means of hard steel cables, pre-stressed on the Freyssinet principle. The completed operation shows the possibility of conducting this type of work under tidal conditions.

Historical.

The Carenage quay was originally constructed, according to the decree of 24th December, 1903, at the same time as the new entrance to the Port of Dieppe. It forms the boundary of the outer harbour to the south side and was the best of the tidal quays, indeed, the only one reserved for the fish trawler fleet. It therefore held considerable importance to the commerce of Dieppe where the wet fish trade occupies 50% of the quayage of the harbour and where the fish traders are packed in a narrow island zone immediately behind the Carenage quay (Fig. 1). It was the west end of the wall which was destroyed by the Germans in July, 1944, a few weeks before evacuation.

This destruction had a disastrous effect upon the industry. It also gave a ticklish technical problem to the engineering staff of the harbour. The solution which was eventually arrived at presented a character somewhat exceptional and comprised the conservation of the damaged foundations. It also gave rise to certain criticisms not only in France but in Great Britain†; of doubts and inquietudes respecting the possible differential settlement that the projected construction may suffer from the marrying of the old work and the new.

This present paper therefore aims at giving sufficient information on the reconstruction, and to indicate that it appears henceforth possible to achieve economically and efficiently the anchorage in a harbour back-fill of a quay wall of some importance.

Description of the Old Wall.

It will be found convenient to give a few particulars of the old wall and the nature of the destruction (Fig. 2). The Carenage quay was constructed in 1906-7 in front of an older wall of the basin which also comprised a sluicing basin with its front apron, return walls and timber jetties, and also of masonry walls of which the most recent dated 1862-3. The wall formed a straight line about 170 m. long and the platform, of a width of 30 m., abutted on the national road Havre to Lille.

The top of the wall was at level of 11.02 m. and the sea bed in front of the wall dredged to a depth of −3.00 m., which gave a depth of water acceptable to the larger trawlers.

The following figures give the tidal particulars of the harbour:

(H.M.V.E.) High water ordinary springs 9.15 m.
(H.M.M.E.) High water ordinary neaps 7.30 m.
(B.M.M.E.) Low water ordinary neaps 2.35 m.
(B.M.V.E.) Low water ordinary springs 0.70 m.

The draught of the trawlers using the port does not exceed 4.80 m.; grounding was exceptional and carried no risk.

The old wall was built of mass concrete with brick facing and coping course of granite. It was founded on compressed air caissons and bedded on gravel at depths of −4.50 to −5.00 m. This type of foundation which not so long ago attracted the favour of engineers had been adopted by the contractors who erected the works in 1906-7 and who did not hesitate to substitute the metal caissons, proposed by the Administration, by caissons of reinforced concrete. This new technique had to be used on a much greater scale in the construction of the breakwaters of the new entrance and it became the object, at that time, of a public note under the signature of M. Herzog, Ingenieur des Ports et Chaussées, in the *Annales des Ports et Chaussées* (1907).

The wall which was thus constructed at Dieppe resembled strangely the quay wall of Chanzy, at Boulogne, built at the same time. Both were gravity walls, and the widths at the foundations only represented 32% of the total height, which indicates great boldness on the part of the engineers. However, whereas the Chanzy wall suffered several dangerous settlements in the run of its existence, the Carenage quay wall behaved perfectly until the day the Germans destroyed it.

The Destruction of the Old Works.

After the landing of the Allies in June, 1944, the German Navy had, in effect, prepared systematically the wholesale destruction of the port and had placed mines in pits drilled behind the walls. This was done several weeks before evacuation and indeed they fired three large mines behind the Carenage quay before the time for withdrawal. These mines had been placed between the ancient and the old wall. The effect was almost complete destruction of the westerly wall above low water and the tilting outwards of the part below low water.

The re-excavation of the ruins was started in May, 1945, and carried on till about June, 1946. This work also comprised the removal of all unsound masonry from the tops of the tilted foundations Above the level of −3.00 m. all debris of the ancient and the old wall was cleared as shown in Fig. 3. It soon became apparent that the old wall caisson foundation had pivoted about the forward edge to an inclination of from 3° to 6° from the vertical. Several constructions to the rear of the wall had suffered similar movements also.

These facts were not encouraging and having regard to the necessities of the port, the reconstruction of some 60 metres of quay which were destroyed gave rise to serious technical considerations.

The Solution Adopted for the Re-construction.

The problem which the technical staff had then to resolve can be summarised :

(a) On account of the narrowness of the outer harbour, that is 150 metres, which already was productive of mooring and manœuvring difficulties to the passenger vessels of the Dieppe-Newhaven Service, a new quay could not be sited in front of the old one, besides, it was desirable to continue the old alignment with the part of the quay still remaining intact.

(b) The trawlers and the smaller fishing boats prefer to moor alongside of a solid wall that is vertical rather than an open faced wharf on R.C. or timber piles. Therefore it appeared to be of advantage to re-establish the mooring face in the form of a continuous wall.

(c) The depth of water at the quay face, such as it was at the level (−3.00 m.) of the dredged bed was judged acceptable, however a little feeble, having regard to the draught (4.80 m.) of water of the modern trawlers.

(d) The ground upon which rested the foundations of the old quay, although it had been disturbed by the effect of the explosions, presented on the whole ample security. It was constituted by a bed of sand and gravel from the top level (−4.00 m.) to bottom level of −10.00 m., that is six metres thick, and there underlaid by a stratum of clay. The bad ground, and notably the bed of peat that one finds at level −3.00 m. to −4.00 m. had been traversed by the sinking of the caissons of the foundation.

(e) The surcharge of the platform, utilised exclusively for the fish cargoes does not exceed two tons per square metre. The level

*Paper presented to Annales des Ports et Chaussées, May-June 1952. Translated from the French.

Re-construction of Carenage Quay Wall at Dieppe—continued

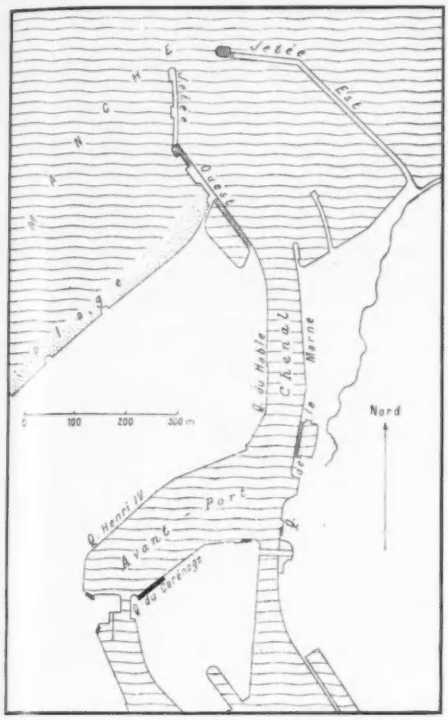
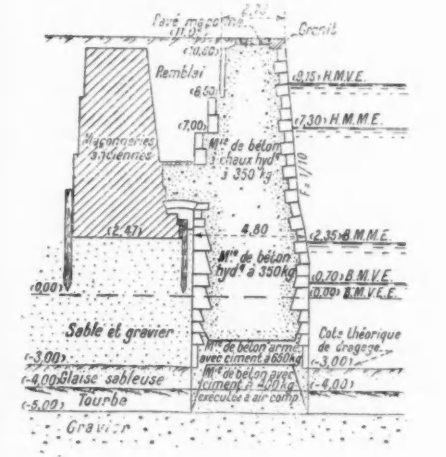
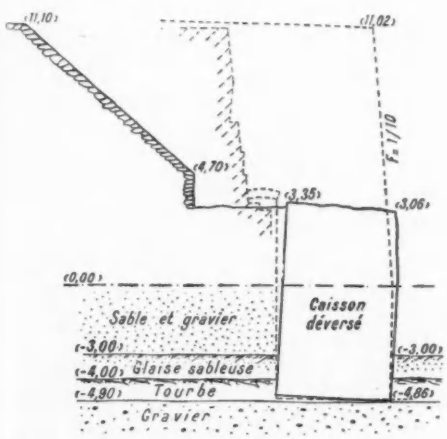


Fig. 1. Plan of harbour, showing position of Carenage Quay.





Figs. 2 and 3. Cross-sections of quay wall, before and after destruction.

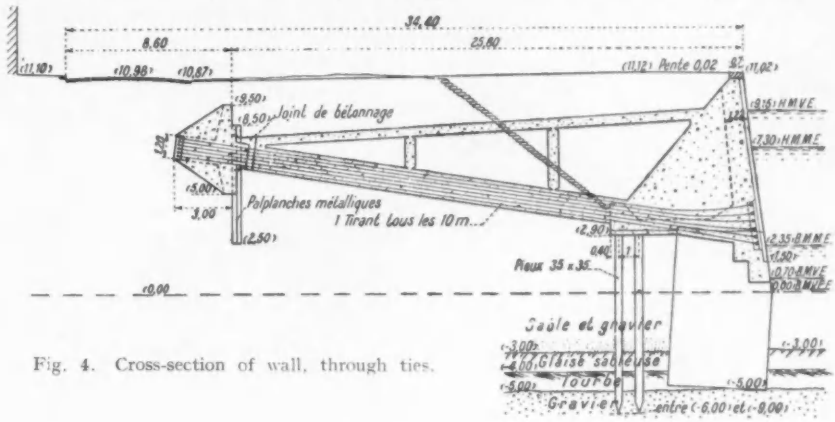


Fig. 4. Cross-section of wall, through ties.

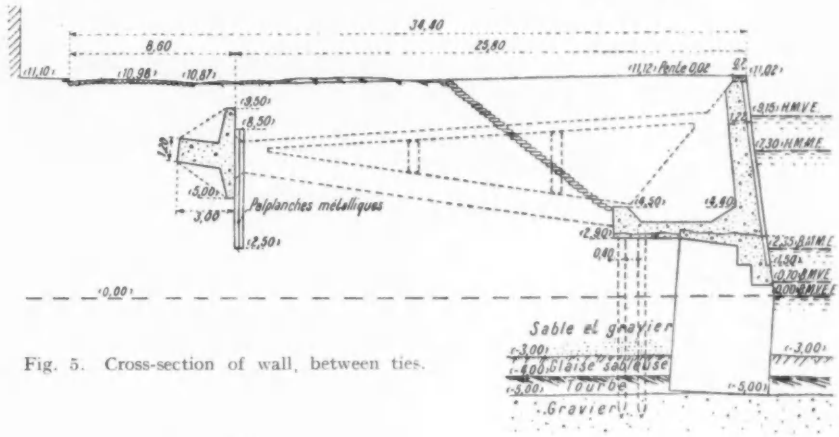


Fig. 5. Cross-section of wall, between ties.

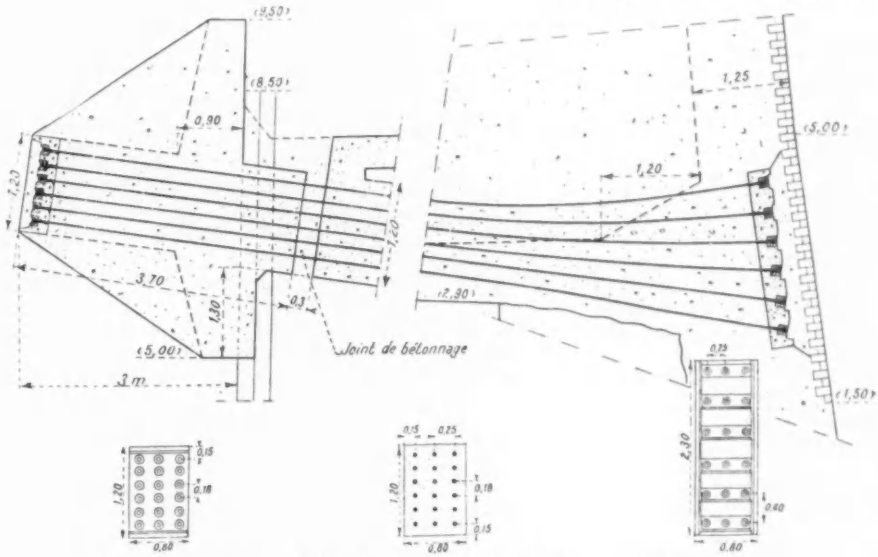


Fig. 6 Anchorage of the ties in distribution wall, and wall of quay.

GLOSSARY

Chenal	Channel	Tourbe	Peat
Avant-Port	Outer harbour	Dragage	Dredging
Beton	Concrete	Deversé	Tilted
Chaux	Chalk	Palplanches metalliques	Steel sheet piles
Sable	Sand	Tirant	Tie
Gravier	Gravel	Pieux	Piles
Glaise	Clay		

Re-construction of Carenage Quay Wall at Dieppe—continued

Fig. 7 (left). Repair of the lower part of the wall face at low tide in the shelter of dams of soil and debris. Fig. 8 (right). View of upper part of new wall showing ties.

of the water table behind the wall varies sensibly with the rise and fall of the tides but it appeared prudent to fix upon a hydrostatic height of about 5.00 m. One did not lose sight of the fact that the springs range is almost 10.00 m., a condition which gives rise to serious problems in the stability of the works.

Of the numerous solutions which were studied for the reconstruction of the Carenage quay, some envisaged the complete removal of the old foundations and their renewal by compressed air sinking as before. Others were based on steel sheet piling anchored into the back-fill, another, and that was without doubt the most simple, involved the underpinning of the tilted foundations and the erection of a timber decking similar to that in service at the Port of Boulogne. Despite the difficulties, the administration decided to reconstruct a continuous wall to the old alignment.

This decision was admissible only if the old foundation was retained, and all the discussion concentrated on the point of knowing if it was reasonable to build a wall subjected to considerable thrust on the foundations which had already commenced to move. The Administration accepted this risk but in agreement with the contractor who executed the work it took special precautions to limit the hazards.

The new wall has then been founded on the old tilted foundation. As a preliminary to all other work two rows of reinforced concrete piles were driven carefully behind the foundation caissons as shown in Figs. 4 and 5. There was thus formed a monolithic assembly in reinforced concrete solidly anchored in the back-fill: the general alignment of the works has been maintained and the mooring face is no different to that of an ordinary solid wall. The details of the new work are shown in Figs. 4 and 5 and comprise : a solid reinforced concrete relieving platform, or transom, which links up the heterogeneous foundations formed by the caissons and the rows of R.C. piles in the rear. This beam has a thickness of 0.70 m. and a width of 7.50 m. It extends to the front of the wall where a downward arm, or flange, is married into the old concrete foundation. On this an upper wall of reinforced concrete, with a brick facing is carried up to the coping level. The coping is of squared granite at the deck level of +11.02 m. Including the brick facing, this wall is 1.22 m. thick and at every 10 m. spacing a reinforced concrete counterfort is rooted in it.

The ties, grouped in pairs, in the vertical plane, are also rooted in the counterforts (Fig. 4). The bottom tie in concrete, 0.80 × 1.20 metres section, has running through it 18 cables, each of 18 strands of hard steel wire 5 mm. in diameter, and placed in tension by the Freyssinet method of pre-stressing. The upper tie is of reinforced concrete 0.50 × 0.50 metres section.

An anchor beam in reinforced concrete is buried in the back-fill at 25.80 m. in the rear of the wall. This beam is 4.50 m. high and the pull it resists is aided by a small curtain wall of steel sheet piling already driven to carry out the excavation and then left in place.

The investigation of the stability of the works so conceived would have provided factors to lead to important mathematical developments; the heterogeneity of the foundations, the multiplicity of the ties, and their rooting in the counterfort would have given highly problematical factors. So as not to abandon the domain of clarity, one is content to verify that with the equilibrium limits of soils and with the tension realised artificially in the ties, the pressures on the foundations of the old caissons should not be sensibly modified before and after the construction of the new works. It is this consideration which has led to put progressively in tension the lower ties in proportion with the execution of the work and the stabilisation of the hydrostatic head of the back-fill. But the advantage of applying this tension responds also to another pre-occupation.

The conception of the work does not permit, in effect, to envisage the least movement in the old caissons of the foundation, a slight inequality of settlement in any one of the caissons could bring about the dislocation of the work and, in particular, the rupture of the attachment of the ties to their counterforts. But then the putting in natural tension of a tie of traditional reinforced concrete involves an elongation appreciable, of the order of 20 mm. for a tie 30 m. long and in consequence implies a drawing in of movement in the work that one proposes to hold. In the case which concerns us there was an evident interest not to accept any movement of this nature and to achieve a state of artificial tension of the ties.

In reality, only the lower ties are in tension, the upper ties are in reinforced concrete and play a part, additional and accessory, in the stability of the work. The tension exercised by each of the lower ties has been fixed at 420 tons.

This value has been obtained in leaving a joint gap of 0.30 m. thick at the throat of the junction of each pair of ties and of the anchor beam (Fig. 4). After applying tension in the steel cables equivalent to a total pull of 420 tons this joint is concreted up.

The procedure was to stress 14 cables in the lower tie, each cable being subjected to a pull of 30 tons which gives effectively

Re-construction of Carenage Quay Wall at Dieppe—continued

the 420 tons required. Only after the concreting of the joint the remaining four cables of the group were stressed. Hence in reserve there is a supplementary pull of 120 tons which can eventually be mobilised; speculating on the slight elasticity of concrete. With these dispositions effectively carried out the pressure of the caissons on the foundation bed remains about 3 kg./cm.^{2} (6000 lbs. per sq. ft.) on the front edge and 2 kg./cm.^{2} (4000 lbs. per sq. ft.) on the back edge.

The Execution of the Works.

The works were executed during 1950 by the Societe d'Enterprise Marbeau which had been declared the contractors at the end of 1949. They required ten months of effective work without special difficulties for completion of contract. As it was the first time that one had placed hard steel of high tensile resistance in works carried out in the tidal range we believe it would be useful to give some details of the progress of the works.

The Securing of the Lower Parts of the Wall Face.

In tilting, the caissons foundations had been pushed outwards and presented since then, at the level where one ought to effect the support, a projection which in some of them attained 0.90 m. Some of the irregularities were due to the original sinking, provoked by the difficulties of driving by compressed air through ancient masonry. It was therefore desirable to effect some security to the facing in the lower part of the works, in a manner to leave no projection that would be dangerous for vessels alongside. One knows that the hulls of trawlers are very thin and are fitted with keels of light section—during the operations of re-provisioning they frequently take on considerable lists, therefore the batter of the wall face of the new work ought not to exceed one in five. This then necessitated the demolishing of the facing of the old masonry down to the level −1.00 m. and to erect the facing of the new masonry from a level placed well below that of the lowest low water.

The Administration had foreseen and prescribed for the execution of this work by means of a small caisson of compressed air. However, the contractor succeeded in making the demolition and erecting the new masonry in satisfactory conditions working in the shelter of low dams of soil (Fig. 7) during the occurrence of very low waters which fortunately favoured the year 1950. It proved a great success, nevertheless it required the co-operation of courageous workers, well experienced in maritime work.

The Upper Wall of the Quay.

This wall has a total thickness of 1.25 m. including the brick facing of an average thickness of 0.165 m. The bricks were coursed alternatively in headers and stretchers to tie in to the reinforced concrete main body. This arrangement was adopted to give a satisfactory appearance without compromising the strength of the wall in introducing two different materials. The brickwork constitutes a simple revetment that has been built up in proportion to the placing of the concrete and which has saved the contractor the expense of double shuttering. The joints of the concrete placings are thus completely masked and the wall is sufficiently watertight.

It behoves us to note that it would have been of advantage to place vertical expansion joints in this wall: its slight thickness makes it, in effect, sensible to thermal dilatation and some cracks have appeared through the thinner wall set-backs for the quay ladders as soon as cold occurred.

Applying Tension in the Steel in Lower Ties.

This operation has been performed by using the same kind of materials and the same methods as those which are fundamental to pre-stressed concrete technique. Carried out in contact with salt water charged with mud and impurities it is to our knowledge one of the boldest applications of the Freyssinet method.

The stressing of the cables in the lower tie was carried out as follows (Fig. 6) :

In the transom beam, the anchorage beam and in the concrete of the lower tie, black steel tubes 38/36 mm. diameter were placed in the designed positions of each cable. A joint gap of 0.30 m. wide had been formed in the junction throat of the ties near to the anchor beam; spanning this gap collapsible sleeves had been fitted (40/38 mm.) over the main tubes severances. To both extremities, the wall face and the anchor beam, of the group of tubes, specially cast reinforced slabs holed to the same pattern as the tubes' extremities at each end respectively were placed in position. These slabs were fitted with hold-tight cones to take the wires of the cables according to the Freyssinet system.

On the front plate, the cones were visible at low tide; on the back plate they were accessible in the pits arranged behind the anchor beam, and the joint gaps just in front of the anchor beam were also accessible. The operations of threading the cables through the tubes and the application of stress had been carefully planned and organised. As soon as the circulation of water in the tubes was stopped, by using wooden plugs in the holes of the cones, it was necessary to clean out the tubes before placing the cables. This was done by water under pressure and the drawing through of a wire brush. The impurities which were cleansed out included rust, mud and some thick oil.

The threading through of the cables of 18 strands did not present any difficulties. The contractor had fabricated at their extremities a conical cork by electric welding. Of the 108 cables which were to be placed one only was impossible to pass, strangely enough through the presence of some obstruction in the tube. The application of the pull in the cables was carried out by means of special jacks at low water and presented no difficulty. The jacks were placed in the pits and the extension of 17 cm. was obtained by one jack only. During that operation no closure of the joints was observed and they were concreted up in each tie after 14 cables had been stressed.

The injection of the cement in the tubes was also carried out at low water. On the average a delay of one month was allowed between the placing of the cables and the final cement grouting. Immediately before that operation the tables and the cables were cleansed with water under pressure. Some difficulty was encountered to secure satisfactory injection because, in spite of the precautions taken, several of the black steel tubes communicated the one with the other. It was only after complete grouting that the terminal cones were protected by concrete masks or brickwork.

Clearing Away Material on Seabed in Front of Quay.

The hydrostatic level of 5.00 m. was operative only after completion of the back-fill. During the whole period of the works one had, in effect, arranged for openings in the new work and had let the sea penetrate freely behind the reinforced concrete wall. These openings were plugged up before the clearance of the fallen material in front of the quay. This clearance was an arduous and costly operation and was carried out by a grab dredger. Only weak charges of explosive were used so as not to damage the new work. The wall was carefully observed and showed no defect in any form. The final dredging was completed to a depth slightly more than originally projected.

Conclusions.

The new Carenage quay was put into service in Spring, 1951. The Administration was pleased with the finished job and had no cause to regret the decision to reconstruct a new work on the doubtful foundations. The solution adopted is not perhaps one to be imitated and the fears that several engineers have manifested about it are understandable. It was a case of a kind which answered to certain exceptional conditions. What appears to us worthy of note is that this work shows the possibility, of carrying out within the tidal range, of complicated works in reinforced concrete. The qualities of cement which are available nowadays and the methods of placing the concrete permit us to affront problems before which our predecessors would have recoiled. The cables of hard carbon steel which have been put in pre-tension in the new wall well illustrate all the possibilities that one may draw from it in tidal work, particularly so if competent workers skilled in maritime works are available.

The engineers have actually a marked preference for the methods of prefabrication and assembly of maritime works. This preference is amply justified when it is concerned with the construction of important works and when powerful appliances can be used. Fortunately for the works executed in secondary ports and even for those secondary ports where the tidal range is considerable, tidal work is yet a wide possibility, and does not hinder recourse to modern technique.

Hydraulics Research

Report on Model Investigations

In the United Kingdom urgent research problems such as coast erosion, flood protection and the silting and scouring of rivers, estuaries and harbours, were, to a very great degree, neglected until 1947. In that year, however, the Hydraulics Research Board was established, and Sir Claude Inglis was appointed as Director of the new D.S.I.R. Hydraulics Research Organisation. Their first report, " Hydraulics Research, 1947/51," was published during the middle of November by H.M.S.O., price 3s. (75 cents U.S.A.) by post 3s. 1½d.

Several years had elapsed before a site for a research station could be acquired, but early in 1951, Howbery Park, near Wallingford, was bought and the first stage of the construction has been begun. Wave basins, a flume and an experimental channel are nearing completion, but the station will not be completely finished before 1957.

Coast Erosion.

The Director's Report indicates that some of the most important work of the Organisation will be that on coast erosion. At present, little scientific guidance can be given to authorities concerned, although large sums of money are spent every year on coast protection. The problems involved are complex and require extensive investigation before coast protection works can be designed with assurance that they will achieve their purpose; at the moment, certain protective measures may well aggravate effects which they are intended to remedy. For example, although groynes or seawalls constructed on coastlines where damage has been serious may be effective in slowing down local erosion. they often cause degradation of other beaches both to seaward and leeward.

Before seawalls are built, the energy of the waves is dissipated as they break and flow back down the beach, but after the wall is built, much of the energy is reflected and heavy turbulence develops in front of the wall, causing it to be undermined. The problem calls for systematic study of the factors affecting degradation and the movement of material along the coast, and this will be carried out at the new Hydraulics Research Station, using model lengths of coastline combined with periodic surveys to secure information regarding trends and cycles of change.

Control of Estuaries.

An investigation of a model of the River Forth, which was undertaken on behalf of the Admiralty, was completed early in 1950. The object of this investigation was to study the effects on the estuary of a number of proposals for new works, including piers for the proposed road bridge over the Forth and some suggested alterations to the dockyard at Rosyth, which it was believed would reduce silting and consequent dredging.

Tidal estuaries may be divided into two main classes. The first class dries out at low-water, leaving only a small stream in the main channel, whilst the second class does not dry out. The River Wyre in Lancashire is a good example of the first class, and the River Thames an example of the second class.

The River Wyre.

An investigation of the estuary of the River Wyre has been carried out on behalf of the Imperial Chemical Industries Ltd., to determine the best way of retaining the low-water channel near the jetty at Burn Naze on the west side of the estuary. The main channel of the River Wyre is subject to cyclic movements swinging across the estuary from bank to bank and back again with a period of 6 2/3 years, and in doing so, it periodically moves away from the Burn Naze jetty. Experiments are now in progress to determine the best design of groyne to guide the course of the channel, so that it will run permanently alongside the wharf, which it is proposed will replace the existing jetty, and yet will cause no ill effects in other parts of the estuary.

On this model a new type of tide generator is being used which can reproduce any tide curve automatically, the profile of the curve being simply fed into the machine on a roll of paper. Cameras with automatic control, which take photographs at predetermined intervals, making changes in the low-water channel obvious, have also been employed in these experiments.

The River Thames.

Nearly half a million pounds is spent annually on dredging the River Thames to maintain a deep-water channel from the docks to the sea. Two models* have been constructed at the Royal Victoria Docks by the Port of London Authority on the advice of the Director, the object of the investigations being to find methods of reducing the expenditure on dredging and for improving the condition of those parts of the channel and docks where siltation is particularly severe. In this case the required depth of the river cannot be maintained without extensive dredging, unless major improvements are carried out in certain parts of the channel, although it is possible, that by judicious dredging at suitable points, the cost of maintenance under the present conditions could be reduced.

The rapid siltation in the tidal basin at Tilbury Docks and the proposals for reducing it, either by structural alterations to the basin or training works in the river, are being investigated.

The expenditure on dredging silt deposited in the docks from the impounding water pumped into them from the river is at present heavy, but investigation has shown that by cutting down the pumping period and by altering the position of the pump intakes, the siltation can be considerably reduced.

Flooding at Carlisle.

A model of the River Eden at Carlisle was used for experiments made in order to test a proposal for the construction of a weir by building coffer dams. This investigation proved that this method of construction would have caused irreparable damage to the river bed and it was accordingly abandoned.

To reduce flooding in and around Carlisle, the bed of the Eden had been lowered and the channel widened, but it was then found that the water must not be allowed to fall below the offtake of the cooling water supply to the Willow Holme power staion. The construction of a weir would solve the problem of retaining enough water in the river and yet allowing flood water to escape. Text book formulæ indicated that the afflux caused by a plain baulk weir would be about 2½-ft. or more than the improvement due to lowering the river bed. Experiments showed, however, that the afflux would actually be less than 1-ft., but even this afflux would reduce the benefit from the scheme by about 40%. A barrage with automatically controlled gates was proposed, but the cost of standard types was considered to be prohibitive. The design is now in hand of a submerged type of gate which will open automatically or be made to open electrically when the water level has reached a certain height and which will close again or be made to close when the water level falls again.

Overseas Investigations.

Experiments on the control of rivers overseas have been successfully carried out, particularly on the Rupnarain River in India, the Zambesi River in Africa, and the Mkondoa River in Tanganyika.

New Instruments and Techniques.

For all these experiments the station has developed new instruments and techniques which include the tide generator used on the River Wyre model, water level meters of various kinds, a multiple velocity meter for measuring velocities in both magnitude and direction at five different points on a vertical at the same time, and controls for the injection of solid materials into the tides to simulate silt. A patent has been taken out for an inexpensive type of flow-meter, which consists of a submerged weir in the line of flow.

Sea Walls and Beaches.

The vital work on coastal erosion has been carried out in a tank 54-ft. x 10-ft., where the long term effect of sea walls on the beaches in front of the is being studied. This tank is equipped with a wave generator and two large wave basins are being built; in one of these currents and tides can also be generated; to be used in the investigation of the velocity and direction of movement of water on beaches and of the effect of groynes on this flow. Particular study is being made of the best designs of groyne systems to reduce erosion to leeward and this work is of urgent interest and vital importance to all coastal authorities.

*See article on " The Thames Model Investigation " in the April 1952 issue of this Journal.

Reconstruction of Craighouse Pier

Designed to Withstand Abnormal Berthing Speeds

By A. M. ROBERTSON, A.M.I.C.E., A.M.I.Struct.E.

In the County of Argyll, which has a coastline of no less than 2,000 miles there are 49 piers in use, 15 of which are operated by the Argyll County Council. The Council plan to reconstruct 7 of these piers and to build 3 new piers at locations where no berthing facilities at present exist. The County Council have statutory powers to construct and operate piers under the "Piers, Harbours and Ferries (Scotland) Act, 1937."

The first of the piers reconstructed is at Craighouse, on the Island of Jura, and incorporates features which may be of some interest.

This pier is situated on the east coast of the island, in the Bay of Small Isles, and is in relatively sheltered water, but not in any way in what could be termed a harbour. A troublesome ground swell enters the bay when south-west winds have been blowing in the Atlantic. The exposed nature of the site is such that only by having alternative berths at right angles to one another can a vessel be brought alongside at all times of the year.

The tidal range at the site is only 3-ft. at mean spring tides, due to the close proximity of the site to the Amphidrome situated between the Island of Islay and the Kintyre Peninsula and this factor together with the shallowness of the water raised some unusual problems to which reference will be made later.

The Isle of Jura, like many of the Western Islands of Scotland, is suffering from a fall in population and by providing adequate pier facilities at each of the Argyll Islands, the County Council hope to arrest the decline and encourage forestry and agricultural development.

Jura is served by vessels operated by Messrs. David MacBrayne Ltd. of Glasgow; one passenger mail vessel of 540 tons displacement loaded calling at the pier six times per week, and a cargo vessel of 600 tons displacement calling every ten days. The service is all the year round, fair weather or foul. The passenger vessel calling at Jura also serves Islay, Gigha and Colonsay. All Messrs. David MacBrayne's vessels serving the west coast of Scotland are of the belted variety—a type necessary for berthing at open sea piers, but very destructive to marine structures by virtue of the high berthing speeds they can stand without serious damage to their hulls.

Another feature of these vessels, which creates forces on fendering different from a merchantman or barge type of craft, is that they are curved on plan, such that the whole impact can be transmitted as a point load on the fendering with the centre of gravity directly behind the point of contact. This form of impact is impossible in the case of a merchantman berthing when either one end comes in contact first, or a long length of hull comes in contact with the fendered face with a small load per foot run acting. A lack of water at West Loch, Tarbert where the passenger vessel leaves the mainland of Kintyre for the islands, and at most of the other pier sites has forced Messrs. MacBraynes to adopt a vessel having only 6-ft. 10-in. mean draft, and this type of vessel is rather difficult to berth in high winds. A photograph of the passenger vessel, the M.V. Lochiel, lying at the new pier is shown in Fig. 1. Figs. 2 and 3 show the pier nearing completion.

It is common practice on the Clyde Estuary and at the West Coast Islands, to berth vessels of 200-ft. long and over, and up to 1,000 tons displacement, at piers having berthing faces of as little as 50-ft. It will be seen that to provide the necessary stability and resilience with such small structures as these and the new pier at Jura which has berths 75-ft. long, the stability problem is closer to that of a dolphin than what is usually known as a pier. It is not surprising that the Argyll County Council has to meet high costs for the maintenance of the fendering on these open sea piers, where at times the berthing velocity is above two feet per second. It is interesting to note that the nominal kinetic energy of a vessel of 600 tons displacement berthing at 2-ft. per second is no less than that of a vessel of 21,000 ton displacement berthing at 4-in. per second, the latter being a fair average speed of berthing in harbour conditions. Figs. 4, 5 and 6 are graphs prepared as a guide for the design of this and other similar piers.

To facilitate berthing under the difficult conditions created by a shallow draft vessel calling at the exposed pier at Jura, a square pierhead with three berths has been provided as shown in Fig. 7.

Figs. 1, 2 and 3.

Reconstruction of Craighouse Pier—continued

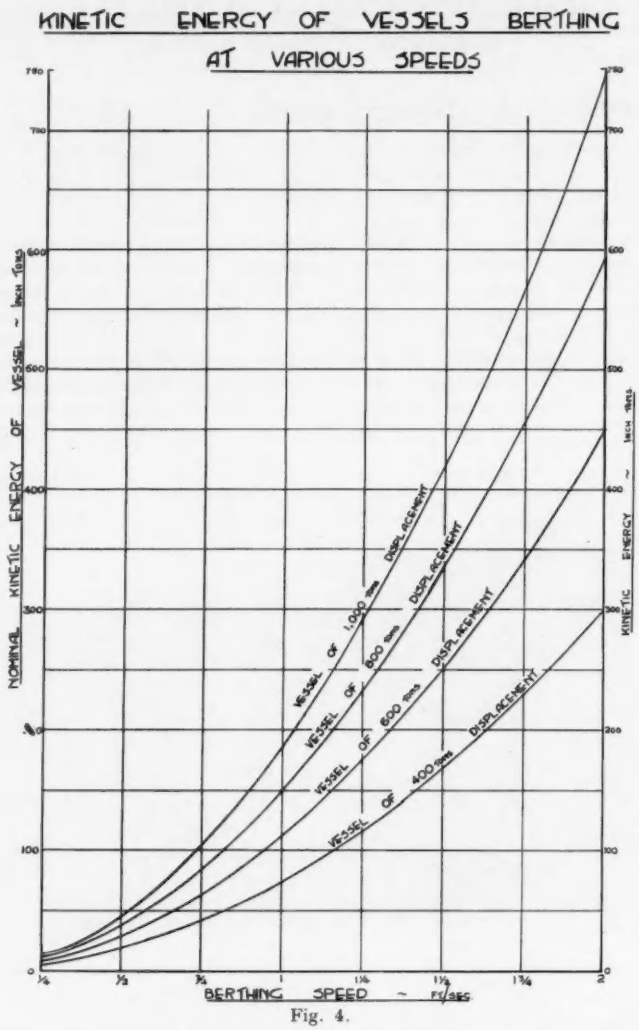

KINETIC ENERGY OF VESSELS BERTHING AT VARIOUS SPEEDS
NOMINAL KINETIC ENERGY OF VESSEL ~ INCH TONS
KINETIC ENERGY ~ INCH TONS
VESSEL OF 1,000 tons DISPLACEMENT
VESSEL OF 800 tons DISPLACEMENT
VESSEL OF 600 tons DISPLACEMENT
VESSEL OF 400 tons DISPLACEMENT
BERTHING SPEED ~ FEET

Fig. 4.

This arrangement allows two vessels to use the pier under normal conditions. In rough weather berthing of a vessel is assisted by making use of anchors and making contact on one of the seaward corners. The functional layout adopted allows of sheltering the approach from impacts, and in consequence reducing the cost of this part of the structure. The plan of the pier also allows of road vehicles turning and parking on the pierhead without difficulty.

The new pier, which extends 100-ft. seawards of the old, is constructed on the line of the original with the approach, measuring 384-ft. long by 13-ft. wide of solid slab reinforced concrete construction, laid on top of the old decking, after covering the latter with a thin hardboard. Using the old deck both for staging and shuttering without cutting into the old structure greatly speeded up the work and cut the time the pier was out of commission to a minimum.

The layout of the piles and deck of the pierhead is unusual and consists of a combination of flat-slab construction and weighted raker pile nests. Bores taken over the site by means of water-jetting a 2-in. pipe to rock indicated that the rock sloped diagonally across the pierhead, being 14-ft. below surface at the south-east corner to 1-ft. at the north-west corner. The bores also indicated that the tension hold to be obtained by rakers would be very small over most of the pierhead. It was however, known from experience that with luck R.C. piles could be driven into the mica schist rock lying under the sand. It turned out that there was no difficulty in driving the 14-in. x 14-in. R.C. piles 5-ft. into the rotten rock without damage provided the stroke of the 2-ton single acting steam hammer used was reduced to 2-ft.

The arrangement of deck adopted for the pierhead allowed the work to be carried out without staging by cantilevering out as with a timber pier, the only temporary piles being 4—12-in. x 12-in. Oregon pine at each raker nest, and a few around the outer edge of the deck. The advantages of having no beams and being able to shutter a quarter of the pierhead at one time without having to wait for steel to be fixed greatly facilitated the work. The shallowness of the whole structure due to the extremely small tidal range, together with the small depth of water available made it economical to use a short span flat-slab form of construction with the unbraced vertical piles laid out on a simple square grid of 11-ft. 4-in. A flat-slab construction was adopted to ensure high grade work of high durability giving a deck of maximum weight at minimum cost to resist head-on impacts.

By grouping the rakers near the corners of the square head a maximum resistance to impacts was obtained and required the minimum of staging. The conical sections of deck over the raker nests not only added weight to the raker piles but provided the necessary puncture shear resistance for the rakers and will be capable of enlisting mass from the deck and the tension hold of piles from a considerable area around each raker nest when a heavy impact has to be resisted. The splayed or conical deck over the raker piles offers less resistance to swell action of the sea than would stone-filled R.C. boxes, as the tide often rises 4-ft. above that predicted when there have been south-west gales in the Atlantic. The absence of beams lessens the risk of serious uplift to the structure under storm conditions. One of the timber piers, now under the Argyll County Council's control at one time suffered serious damage by uplift resulting in the piles at the shore end being extracted.

The exposed nature of the site, the shallow draught of the vessel used all the year round give rise to the rather high berthing speeds, and the usual 1-ft. per second was considered too low a velocity for the calculations. It was decided to design the structure to resist the full nominal K.E. of a vessel of 540 tons when berthing at 1½-ft. per second, namely 180-in. tons, when the timber fendering was stressed in bending to half the breaking stress. To minimise the forces acting on the R.C. structure, and to prevent damage to the belting of the vessels, and denting of the fender facing straps, it was decided that the load acting at the time of impact should not exceed 90 tons. This figure is approximately the ultimate resistance of the beltings provided on the vessels using the pier. With a K.E. of 180-in. tons, it is necessary that the fendering should deflect 4-in. under a load of 90 tons. Some of the other factors considered when selecting the load-movement characteristics and arrangement of the fendering are as follows:

(a) The K.E. of a 540-ton vessel berthing at 2-ft. per second is 400-in. tons, which can be absorbed by a 40 per cent. increase of stress in the fendering. That is when the stress rises to 70 per cent. of the ultimate.

(b) The fendering when stressed in bending to breaking point would absorb 4.5 times 180, equal to 800-in. tons, which means that the fendering would have a factor of safety of nearly two on a 2-ft. to a second impact, provided the loading was symmetrically applied.

(c) A 12-in. x 12-in. Greenheart fender pile as used would deflect 4-in. when stressed to approximately half the ultimate stress.

(d) Fig. 6 shows the work absorbed by Greenheart fenders in bending when stressed to half the ultimate figure and the work absorbed when breaking point is reached will be approximately 4½ times that shown on this figure. This means that a single 12-in. x 12-in. Greenheart pile 22-ft. long can, before breaking, if loaded without torsion absorb a K.E. of 175-in. tons which is the full K.E. of a vessel of 600 tons displacement berthing at 1¼-ft. per second.

(e) Impacts of over 1½-ft. per second acting at deck level would crush the belting of the vessel and restrict the load acting to 90 tons.

(f) The centre of gravity of the Mail Steamer is 2-ft. 4-in. above the centre line of the belting, which allows the vessel to absorb work by rolling on impact. The work absorbed by

Reconstruction of Craighouse Pier—continued

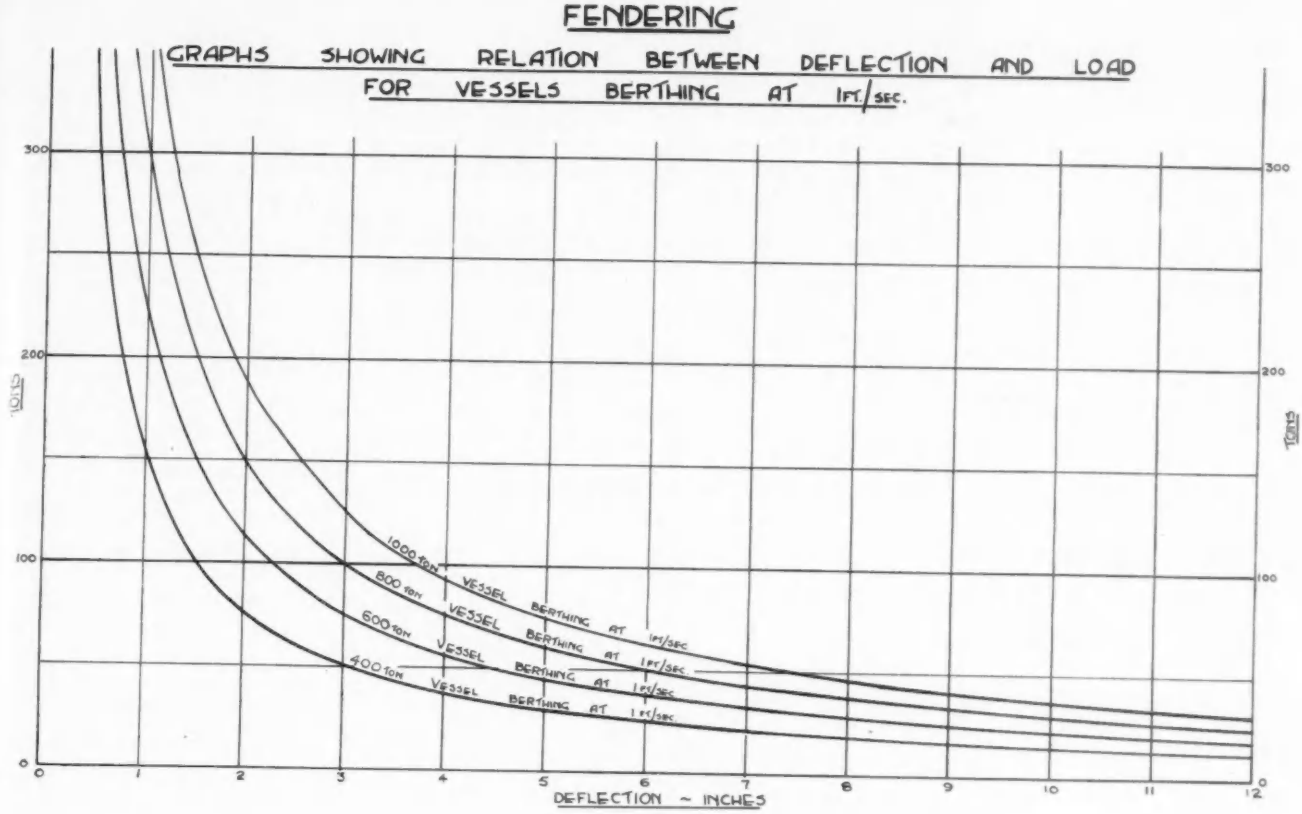

FENDERING
GRAPHS SHOWING RELATION BETWEEN DEFLECTION AND LOAD FOR VESSELS BERTHING AT 1FT./SEC.
1000 TON VESSEL BERTHING AT 1FT/SEC.
800 TON VESSEL BERTHING AT 1FT/SEC.
600 TON VESSEL BERTHING AT 1FT/SEC.
400 TON VESSEL BERTHING AT 1FT/SEC.
TONS
DEFLECTION ~ INCHES

Fig. 5.

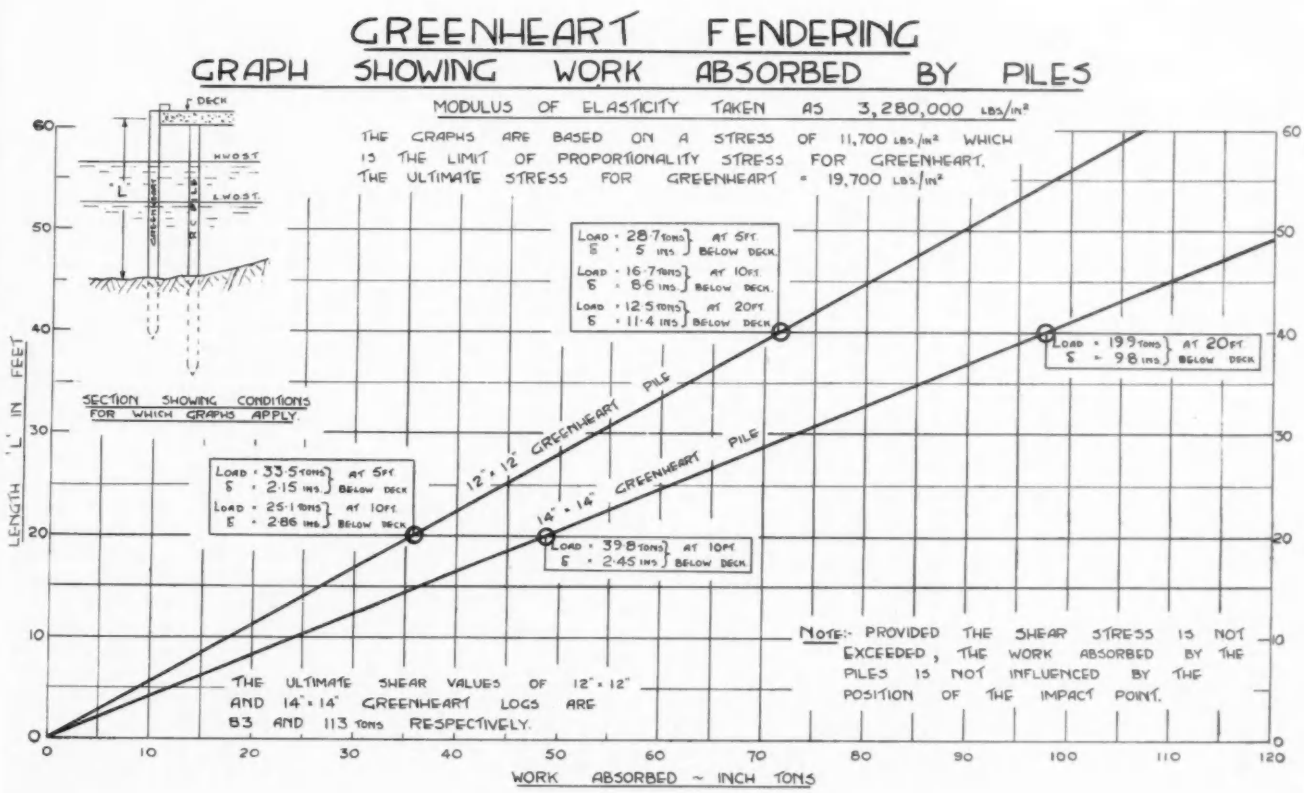

GREENHEART FENDERING
GRAPH SHOWING WORK ABSORBED BY PILES
MODULUS OF ELASTICITY TAKEN AS 3,280,000 LBS/IN²
THE GRAPHS ARE BASED ON A STRESS OF 11,700 LBS/IN² WHICH IS THE LIMIT OF PROPORTIONALITY STRESS FOR GREENHEART. THE ULTIMATE STRESS FOR GREENHEART = 19,700 LBS/IN²
LOAD = 28·7 TONS, S = 5 INS. AT 5FT. BELOW DECK.
LOAD = 16·7 TONS, S = 8·6 INS. AT 10FT. BELOW DECK.
LOAD = 12·5 TONS, S = 11·4 INS. AT 20FT. BELOW DECK.
LOAD = 19·9 TONS, S = 9·8 INS. AT 20FT. BELOW DECK.
LOAD = 33·5 TONS, S = 2·15 INS. AT 5FT. BELOW DECK.
LOAD = 25·1 TONS, S = 2·86 INS. AT 10FT. BELOW DECK.
LOAD = 39·8 TONS, S = 2·45 INS. AT 10FT. BELOW DECK.
12" × 12" GREENHEART PILE
14" × 14" GREENHEART PILE
SECTION SHOWING CONDITIONS FOR WHICH GRAPHS APPLY.
DECK
H.W.O.S.T.
L.W.O.S.T.
GREENHEART
'L'
NOTE:- PROVIDED THE SHEAR STRESS IS NOT EXCEEDED, THE WORK ABSORBED BY THE PILES IS NOT INFLUENCED BY THE POSITION OF THE IMPACT POINT.
THE ULTIMATE SHEAR VALUES OF 12" × 12" AND 14" × 14" GREENHEART LOGS ARE 83 AND 113 TONS RESPECTIVELY.
LENGTH 'L' IN FEET
WORK ABSORBED ~ INCH TONS

Fig. 6.

Reconstruction of Craighouse Pier—continued

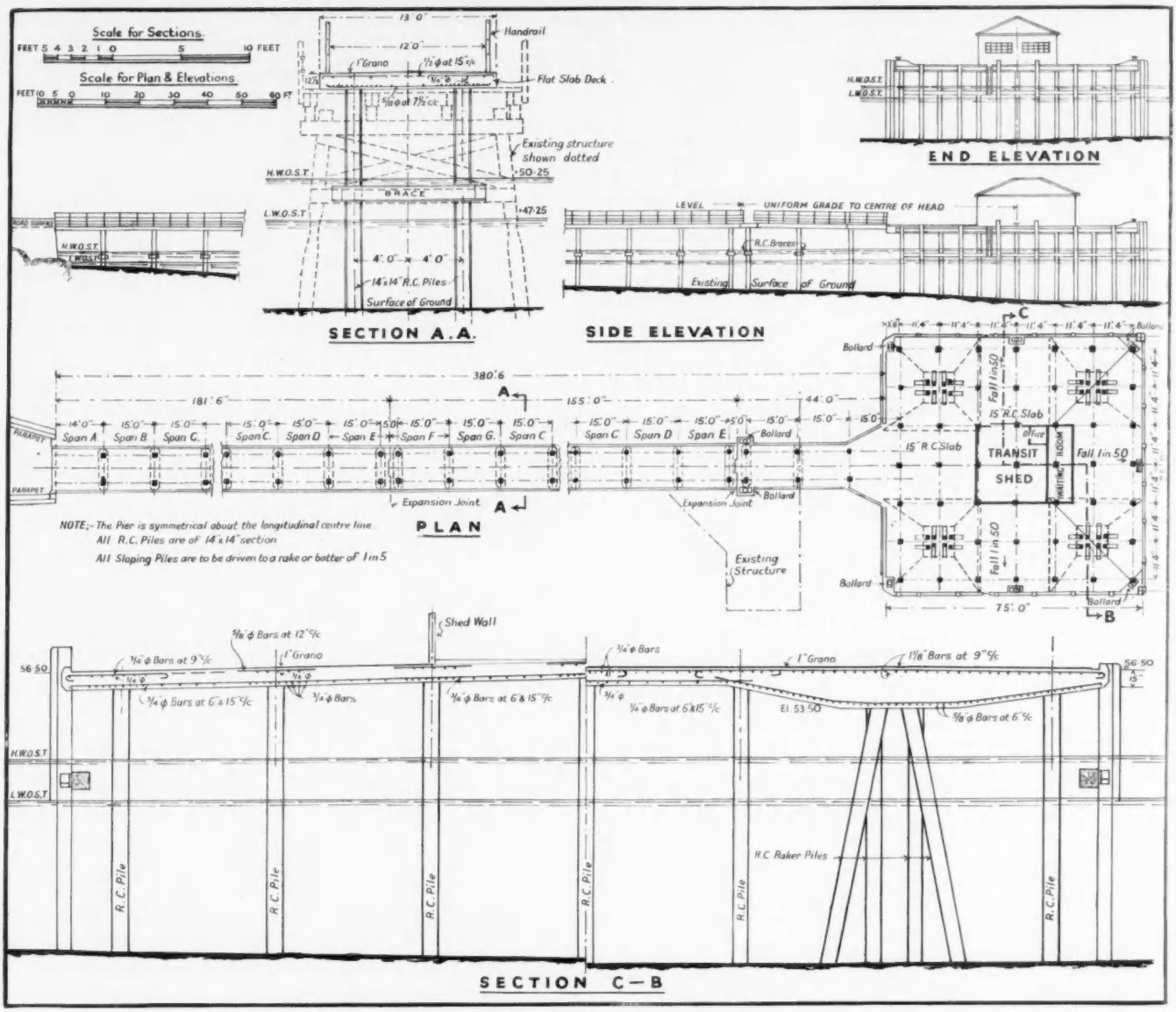


Fig. 7.

this means has been treated as a factor of safety against breaking the fendering when berthing in the region of 2-ft. per second.

To maintain this shock-absorbing capacity at all levels, rubber buffers were introduced between the heads of the piles and the deck. The fendering is shown in Fig. 8. The corner fender piles cantilever up from the walings, and by leaving a gap of 4-in. between them and the deck (without rubber pads) a very resilient corner is provided capable of deflecting in any direction. The corners are most effective and they move approximately ½-in. at deck level under very gentle impacts. The load movement characteristics of the rubber buffers are shown in Fig. 10, and from this information and site observations of the movements of these buffers it is hoped to determine the K.E. transmitted to the fenders. The shallow height of the structure from deck to sea-bed greatly reduces the K.E., a normal fender pile can absorb as will be seen from Fig. 6, and as floating fenders cannot be used with belted vessels, a 16-in. x 16-in. Greenheart waling is provided behind the fender piles. The bending tests on Greenheart shown in Fig. 9 were carried out at the Glasgow Technical College to check published figures and they showed this material to have a breaking stress of 22,800 lbs. per sq. inch, no less than ⅓ that of mild steel. The latest published figures for Greenheart give a breaking stress of 19,300 lbs. per sq. inch for logs of the sizes normally imported. As the vessels are seldom steady when lying alongside this pier, 6-in. x 1-in. convex steel facing straps are provided on the fenders to prevent the beltings of vessels cutting into the timbers.

With the information available, together with site observations, it is hoped to establish just how much of the K.E. the vessel does absorb and to collect design data for the other exposed piers to be constructed by Argyll County Council.

Most of the piers in Argyll have suffered a head-on collision at some time, and for this reason it was decided that irrespective of the type of the fendering, this contingency should be provided for by having a pierhead with a high static resistance and considerable mass. It is believed that this pier with a static resistance in the region of 90 tons to bow-on blows, will, if rammed, buckle the bows of the vessels, and in this way restrict damage to a local area of deck and make the vessel absorb the bulk of the impact.

The decks of the pierhead and approach are designed to carry, with the usual stresses, either:

(a) 600 lbs. per sq. foot.

Reconstruction of Craighouse Pier—continued

(b) A 12-ton load acting on a 1-ft. square, or
(c) A modified form of the Ministry of Transport loading, namely, the standard uniformally distributed load plus a knife-edge load of 1,350 lbs. to the foot run acting in the usual way.

The 12-ton load on a 1-ft. square is intended to cover heavy objects being handled by jacks etc. and the landing of such objects by ship's derrick. The bollard pulls have been taken as 20 tons, based on the breaking load of the ropes used.

The concrete aggregates consisted of whinstone from Dumbuck and sand dredged from Loch Sunart, both complying with B.S.S. No. 882. All concrete was consolidated by internal vibrators, and this not only allowed the use of low w/c ratios but allowed the work to be carried out with a reduced number of men. The mix used for piles was approximately 1 : 1¼ : 2½ with a water/cement ratio by weight of 0.40, having an average 28 days site cube strength of 6,143 lbs. per square inch, with maximum and minimum cube strengths of 6,850 lbs. per square inch and 5,040 lbs. to the square inch respectively. The deck mix was approximately 1 : 1½ : 3 with a water/cement ratio by weight of 0.45, having an average 28 days site cube strength of 4,650 lbs. per square inch, with maximum and minimum cube strengths of 6,540 lbs. per square inch and 3,420 lbs. per square inch respectively. All concrete aggregates were gauged by volume; the cement being by full bag.

The pierhead was constructed in four sections, prior to any work being carried out on the new approach. The contractors Messrs. H. M. Murray and Co., of Glasgow, carried all staging and shuttering (with the exception of four temporary timber piles at each raker nest) on clamps attached to the R.C. piles, after determining the safe load carrying capacity of the clamps which consisted of a 12-in. x 6-in. timber each side of the pile, bolted together with one 1⅛-in. diameter bolt each side of the pile. These clamps worked very well and saved endless time and work.

The contractors carried out the work within a period of 15 months, with only twelve men on the site. The deck concrete was internally vibrated at the contractor's request, as a means of saving labour by mechanisation. No difficulty was experienced due to over or under vibration and very little trouble from "bleed-

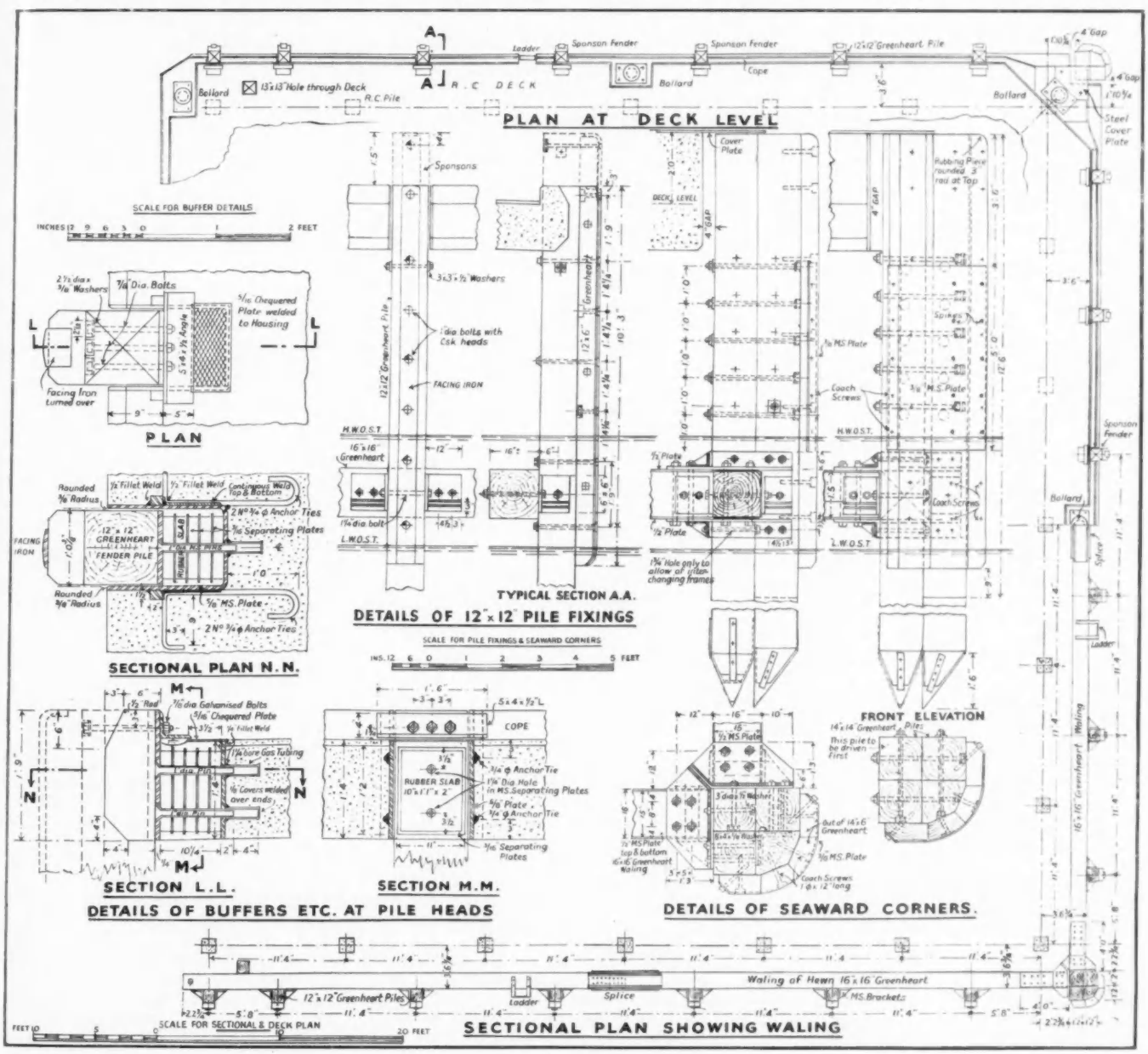


Fig. 8.

Reconstruction of Craighouse Pier—continued

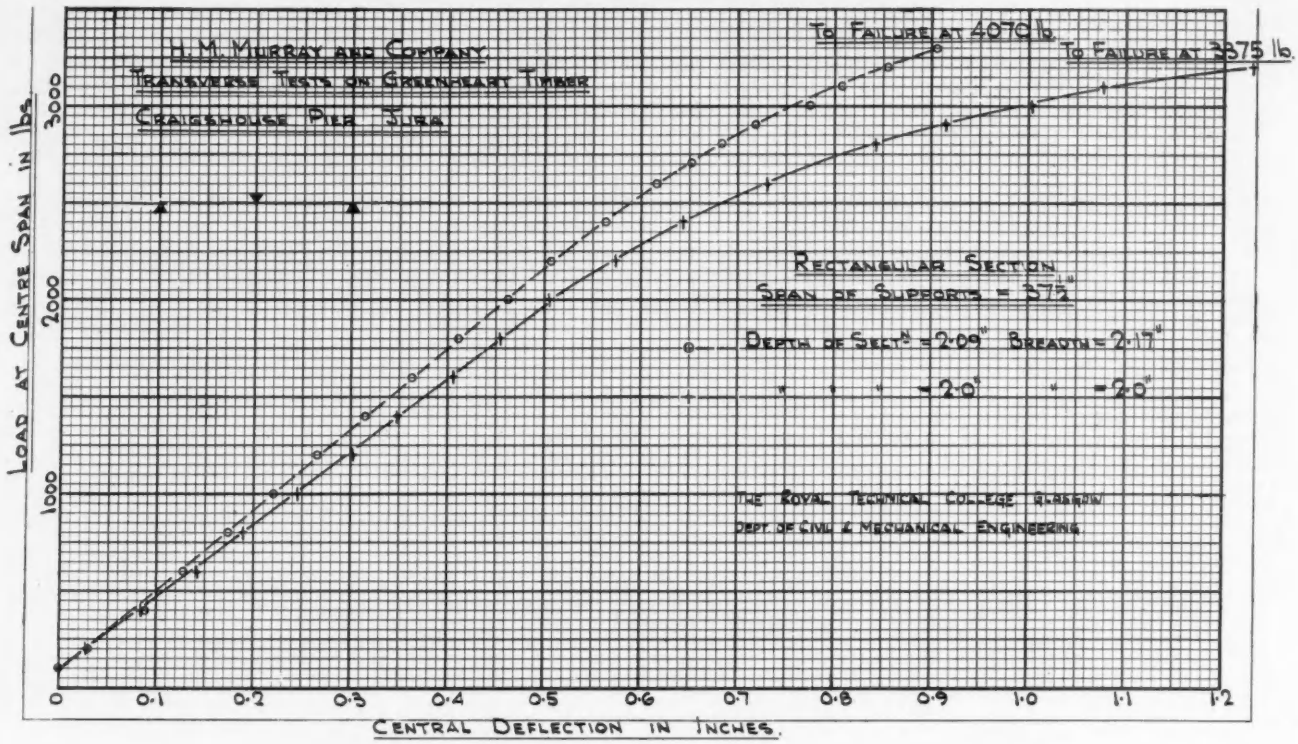

H. M. MURRAY AND COMPANY
TRANSVERSE TESTS ON GREENHEART TIMBER
CRAIGSHOUSE PIER JURA
TO FAILURE AT 4070 lb.
TO FAILURE AT 3875 lb.
RECTANGULAR SECTION
SPAN OF SUPPORTS = 37½"
DEPTH OF SECTN = 2·09" BREADTH = 2·17"
" " " = 2·0" " = 2·0"
THE ROYAL TECHNICAL COLLEGE GLASGOW
DEPT. OF CIVIL & MECHANICAL ENGINEERING
LOAD AT CENTRE SPAN IN lbs.
CENTRAL DEFLECTION IN INCHES.

Fig. 9.

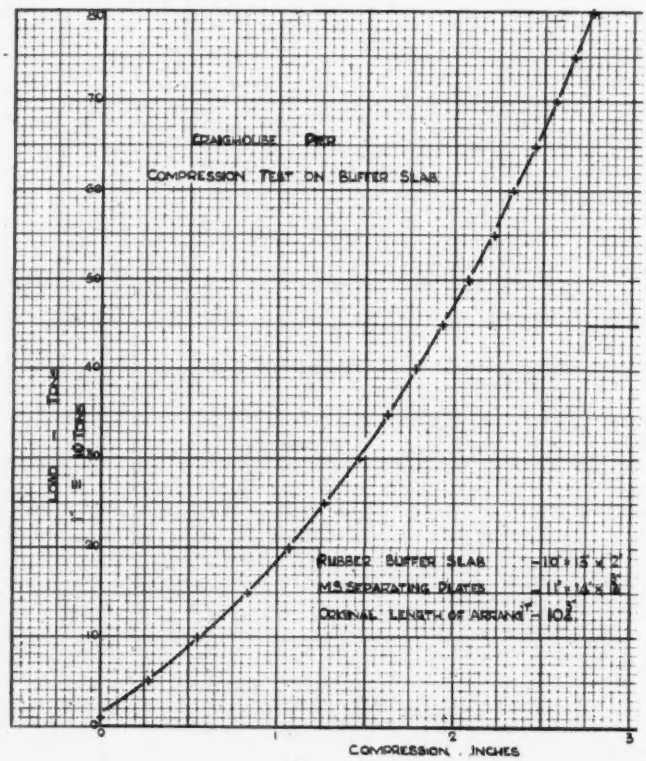


Fig. 10.

ing" was experienced. All piles were cast on the site, the pile casting area being finished off as a parking place at the root of the pier on completion of the work. Most of the plant was carried to and from the site by " puffer," the name given to the Clyde lighters which have a carrying capacity of approximately 100 tons. A 10 R.B. was ferried to and from the island by means of an ex-landing craft.

Although the advantages of the flat-slab form of construction are many and have been referred to in a paper by Rooke*, it is worth recording that on this particular type of work, the greater speed of construction possible should be taken into account when comparing the cost of flat-slab as against beam and slab construction. In this particular pier, it is believed that three months time was saved by using the solid slab form of construction. The safe platform provided over the water by the simple shuttering compared with the broken-up arrangement of shuttering usually found necessary with beams greatly facilitated the work. The time required for stop ends was also greatly reduced.

The surprising feature of the work was that the cost to the contractor on account of inclement weather was only £48.

The cost of the completed work was £43,000, which included the provision of a transit shed, waiting room and parking place, also the demolition of the old pier.

No *Toredo Nevalis* were found in the Greenheart of the old pier, unlike other old Greenheart piers demolished at Stornoway in 1937, where it was found that the Greenheart piles had been bored by a limited number of *Toredo Nevalis*, with holes not exceeding ½-in. in diameter.

The Author, who acted as Consulting Engineer for the work, is indebted to the Argyll County Council for permission to publish this article, and also to Mr. John Shand, B.Sc., who was the Resident Engineer, for the photographs.

*Paper read to the Maritime and Waterways Division of the Inst. of C.E. Session 1949-1950.

Progress on Colombo Port Scheme.

On the 23rd November last, the steamer *Mahsud*, 7,578 tons, of the Brocklebank line, berthed alongside the first of several new piers to be completed under the £6m. Colombo port development scheme, details of which were published in the December, 1951, issue of this Journal. The event is compared locally with the completion of the breakwater nearly 80 years ago which made Colombo a sheltered harbour. The ship's cargo included steel for the construction of warehouses on the new pier.

Pallets and the Port Industry

(1) The Pallet as a Handling Tool : Developments in the Port of London Authority's Docks

By E. S. TOOTH

OF the many new types of goods-handling machines which have become available in the post-war era, the fork lift truck has been the most revolutionary—but only for certain industries. For others, the port industry among them, it has been the most controversial. Theoretically it should have been possible to introduce fleets of fork lift trucks (now beginning to be called " high lift trucks ") into the docks and harbours of this country and thus completely to mechanise the handling through our ports of both import and export cargoes.

Since the last war, the Port of London Authority has tenaciously pursued a policy of mechanisation. Over a hundred modern electric luffing quay cranes of 80-ft. radius and either 5 tons or 3 tons capacity, a similar quantity of mobile cranes of capacities ranging from 1 ton to 12½ tons and numbers of rail mounted cranes, fork lift trucks, electric platform trucks, piling machines, heavy duty tractors and appliances for trimming bulk sugar have been ordered and most of them delivered. Besides these, new grain elevators, floating derricks, tugs, grab hoppers and barges are in commission.

All this equipment, with one exception, has been quickly absorbed into the operating work. The one exception is the fork lift truck, which required an experimental period.

Fork lift trucks must in most instances be used in conjunction with pallets. Pallets for port work may be classified under two headings, viz. (1) those used as handling tools, and (2) those used as " permanent " parts of unit loads of goods.

The development of traffic in palletised unit loads (heading (2) above) does not lie in the hands of the port industry. Dock and Harbour Authorities must be prepared to deal with such traffic if and when it is presented to them but it is not within their province to develop it. At the present time, in point of fact, except in a minor degree in the short sea trades, there is virtually no " unit-load " traffic passing through British ports. Dock and Harbour Authorities can, however, endeavour to extend the use of the pallet as a handling tool and in this sphere the Port of London Authority has been among the pioneers.

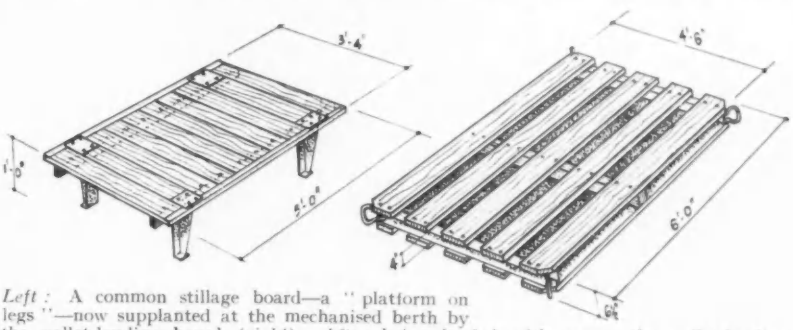
Even before the end of the last war, that Authority had begun tentatively to plan the reconstruction of damaged and demolished premises. When, immediately hostilities finished, these plans were being developed, it was realised that the experience of the past was by no means a complete guide to the future. Rapidly changing conditions made far-sightedness essential. For one thing, it was necessary to take into consideration the probable effects, on the designing of new premises, of developments in cargo-handling methods. Particular attention, therefore, had to be paid to such details as the height of transit sheds, the type of floor, the dimensions of doorways, the desirability of incorporating loading banks and the need, if any, for fixing hoisting equipment. Had such essentials not been given serious consideration, the opportunity to use the new types of cargo-handling machines which later became available would have been partly lost.

In 1939, London's docks were well equipped with the various types of mechanical appliances then in current use in the industry. Between 1940 and 1945 the destruction of much of this equipment, together with the imperative need for the quicker turn-round of ships, stimulated experiments with any machine likely to make for speedier handling of goods to or from ship or through dock premises. Foremost among these appliances was the mobile crane —a machine which is now a permanent feature of the port's work —but here and there in the docks the fork lift truck was also being employed. At first it was used mainly for handling Service stores and equipment but it soon became apparent that this intriguing machine, built primarily for the factory, had great possibilities if it could be generally introduced into port operating work. Owing to the exigiences of the time, however, it was left to the post-war era to experiment with it more thoroughly.

The Port of London Authority's main long-term experiments in complete mechanisation have taken place at the West India Docks and have revolved round the use of the fork lift truck. When first employed for commercial work, this truck was used mainly empirically. Very quickly, however, its obvious potential worth was established and, with the co-operation of the Transport and General Workers' Union and the men employed at one particular quay, the Authority conducted a series of preliminary experiments to determine how best it could be incorporated into export work. Its potential benefits were savings in time, space and arduous labour, and the aim of the experiments was to make these real.

Slowly the workpeople became familiar with the machine and they liked its possibilities. Its use was seriously restricted, however, unless pallets were employed and since, as already stated, virtually no traffic was (or is) tendered to the docks already palletised, pallets could only be used if employed as stillage boards. Consequently, unless the full use of the fork lift truck was to be lost, it devolved upon the Port of London Authority to purchase pallets and use them as stillages. This it was decided to do and the experimental period mentioned was also a period of evolution, not only for the trucks but for the pallets as well.

The truck finally selected for the experiment proper was a robust diesel-driven machine, having three point suspension, twin pneumatic tyres, hydraulic steering and a turning radius of 83 inches.



Left : A common stillage board—a " platform on legs "—now supplanted at the mechanised berth by the pallet-landing board (*right*). After being loaded with cargo, the pallet-landing board is carried on the forks of the fork-lift truck, and is subsequently lifted aboard ship by hooks engaged in its four eyes.

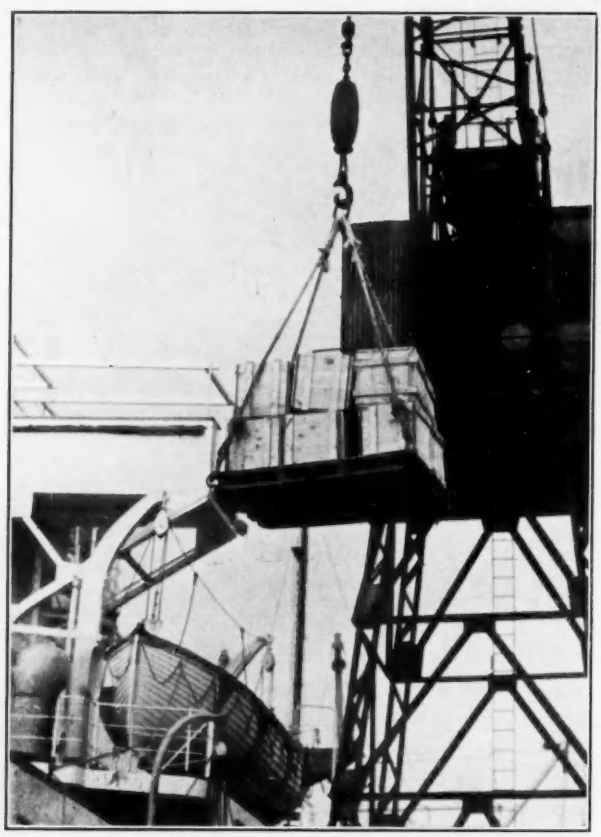
Its width was 50 inches and its length, less forks, 95½ inches. It lifted 5,000 lbs. at 20 inches from fork heels to a height of 12-ft. in 18 seconds. Mast tilts were 3° forward and 10° backwards. It travelled 7.5 miles per hour forward and 10.8 miles per hour in reverse. A rigid crane attachment for lifting awkward loads not easily handled on the forks was also obtained.

The pallet evolved through several stages before a tool was produced which was deemed satisfactory for the work involved. Metal and wooden pallets of varying dimensions were tried and then a winged pallet which could be lifted on board ship by rope or wire slings. Winged pallets, however, were found to be particularly vulnerable to damage and the final development was a pallet with welded metal eyes.

This design was first conceived in the West India dock. The new pallet measured 6-ft. by 4-ft. 6-in., its faces were strong wooden slats, its centre bearer wooden and its end bearers mild steel channel. The eyes were welded to the ends of the metal

Pallets and the Port Industry—continued

Left: Striking exports from lorry on to a pallet-landing board. The fork-truck waits to take the load into the dock-side transit shed for stowage. *Right:* A loaded pallet being placed in its "port" stowage. When required, it will be conveyed to ship's side for lifting into hold.



[*All illustrations by courtesy of the "P. L. A. Monthly*

Lifting a loaded pallet from quay into hold.

bearers and the result was a pallet-landing board, a piece of equipment which could be conveyed on the ground by fork lift truck and lifted aboard a ship by crane or winch. Its carrying capacity was three tons.

Because of the scarcity of certain materials, machines and even pallets took many months to obtain. By the spring of 1951, however, it was considered that adequate experience had been gained and sufficient satisfactory equipment was to hand to mechanise one export berth. With the workpeople's co-operation, a rational manning scheme was worked out and what was in effect a pilot experiment in completely mechanising an export berth was launched.

Goods tendered either by road or rail vehicle were struck on to the pallet-landing boards, which were then picked up and piled three or four high in shed by fork lift truck. The cargoes dealt with were mainly those for South Africa and the Mediterranean and it was found that of the goods struck, some 95 per cent. could be palletised direct from vehicle, 3 per cent. could be palletised after pitching on shed floor (mainly for the purposes of H.M. Customs) and only 2 per cent. could not, or need not, be palletised. This very small percentage consisted in the main of goods which could be handled by fork lift trucks; the balance, almost negligible in quantity, was placed on wheeled trucks and towed to stowage. These figures do not, of course, include vehicles on wheels.

Special arrangements were made with both H.M. Customs and the Shipping Company's Cargo Superintendents which permitted respectively the necessary examinations and the appropriate tallying of the goods loaded on the pallets. The result was that when it was necessary to convey the loaded pallets to the ship's side, there were no delays of any description and the fork lift trucks could easily keep the ship's gangs fully employed. Indeed, the drivers had ample time to leave loaded pallets in reserve at the ship's side and to collect and convey to the shed unloaded pallets which had been returned by the ship and received on to the quay. The stevedores in the hold were thus rarely kept waiting for cargo, not only because of the constant supply at the ship's side but also because, in the majority of cases, all the men on the quay had to do to get the sets aboard was to place four hooks in the pallet-eyes and signal the crane or winch driver to hoist.

From time to time during the experiment, representatives of the Authority and the workpeople met to discuss improvements to the scheme. These meetings were held at various levels and the experience gained was pooled. Agreement has now been reached on most points. Mobile cranes of up to four tons capacity, fork lift trucks of the type already described but equipped with towing bars, and 6-ft. by 4-ft. 6-in. pallet-landing boards have been provided at considerable cost and, with gangs of appropriate strengths, the mechanised work is proceeding smoothly.

In the mechanised shed, exports are now regularly unloaded by mobile crane on to pallets and are piled in shed up to sixteen feet high, so that the shed will now accommodate 100 per cent. more cargo. The proportion of goods palletised has increased to 97 per cent. direct from vehicle plus 2 per cent. from shed floor. There is comparatively little manual handling and no arduous

Pallets and the Port Industry—continued

work. With the need for increased skill goes the discovery of greater interest in the job. There is no reduction in the total cost of handling a ton of exports because the heavy expense of maintaining and replacing the equipment offsets savings achieved in other directions. The remuneration of the men employed, however, is greater than with manual work. Another pertinent point is that damage to cargo is reduced.

The biggest benefit—and indeed the primary reason why the experiment was pursued so tenaciously—has been the saving in loading time. With the cargoes in question, it is true to say that the speed of loading in ship from quay has increased by some 20 per cent. (deadweight tonnage) since fork lift trucks were first introduced. This figure is considerable but it is believed that it can be improved upon. Greater familiarity with the equipment, the discovery of new knacks of handling and the improvements which will inevitably be made to both machines and methods of working are together likely to make for still closer co-operation between quay and ship gangs.

The ideal development in handling exports, which the fork lift truck makes possible is, of course, the movement of goods in palletised unit loads. The method is to build the packages into "permanently" palletised economic unit-loads at the point of production (or at least before they are tendered to the docks) so that they can be handled in this form at every stage of their journey to ultimate destination. The main incentives are lower handling costs, speedier despatch and reduced pilferage risks.

The method involves, however, not only the actual palletising but also a degree of standardisation of pallets, of transport and of handling machines, both here and abroad, sufficient to enable the units to be handled speedily at any point and without loss of space in any vehicle or in ship's hold. Its introduction, therefore, is no trivial matter. Many interests would have to revolutionise their working arrangements. In the exporting country alone, manufacturers, shippers, cartage contractors, railway companies, labour contractors, dock workers' unions, customs authorities, cargo superintendents, port authorities and shipping companies would be involved. Makers of pallets and machines would also be concerned; shipbuilders, too, would have to keep abreast of developments.

The unit load method for handling, poses, therefore, a most complicated problem, the solution of which is obviously long-term. It is, nevertheless, an ultimate ideal, towards the achievement of which, the Port of London Authority, by the action described, may well have taken an initial step.

It is of interest to note that direct action in the sphere of pallet standardisation is being taken at the present time. Representatives of a number of countries this month attended a conference in London to discuss the question from the international standpoint. This conference was, in fact, a three days' meeting of a technical committee of the International Organisation for Standardisation, the British Standards Institution providing the secretariat.

A second article on the subject "Pallets and the Port Industry" will appear in the January issue of this Journal and will deal with "The unit load method for goods handling."

Hydrographic Survey Records

Problems Concerning Rapid Interpretation

By Lieut-Cmdr. A. D. MARGRETT, R.D., R.N.R

Although the principles of carrying out hydrographic surveys are well established, nevertheless certain problems concerned with the rapid interpretation of echo sounder and current meter records still exist. It is therefore proposed in this article to describe for each a rapid and accurate method which eliminates a great deal of the tedious nature of the work often associated with reading off these records.

Echo Sounder Records.

An echo sounder specially designed for hydrographic survey work enables the surveyor to carry out sounding operations at a fast and economic speed. However, on completion of the work afloat it is still necessary to interpret the records and read off the soundings, reduced to the required datum.

In interpreting the records of the Kelvin & Hughes MS 21 A Echo Sounder, for example, it is necessary to prepare a permanent set of scales as described below. This entails a set of eight scales consisting of a deep and a shallow speed set for the following chord lengths: 4.81-in., 4.83-in., 4.79-in. and 4.75-in. These scales should be engraved on thin perspex or drawn in ink on any stout plastic tracing material in accordance with the drawing shown in Fig. 1. In the case of the dry paper teledeltos recorder, scales similar in design will have been supplied with the equipment. In this case, as there are no shrinkage problems, only one fixed chord scale is necessary.

In order to use these scales it is necessary to carry out the following calibrations and adjustments to the recorder before commencing sounding:—

(a) Line up the leading edge of the interval dots to coincide with the zero of the scale on the recorder.

(b) Set the transmission zero (T.Z.) so that it reads the oscillator depth on the recorder scale; zero of the scale or leading edge of interval dots will then be the true water line zero (T.W.L.Z.).

(c) Set the machine to run at the correct revolutions for the local speed of sound in water. This is carried out by means of the bar check or other suitable method.

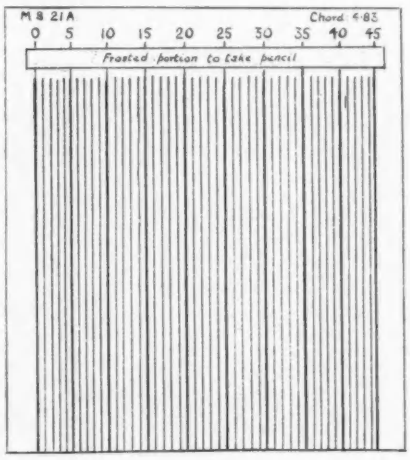


Fig. 1.

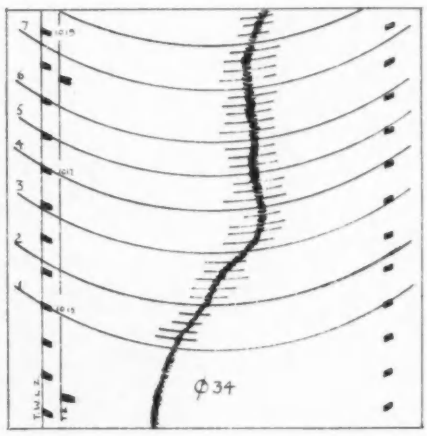


Fig. 2.

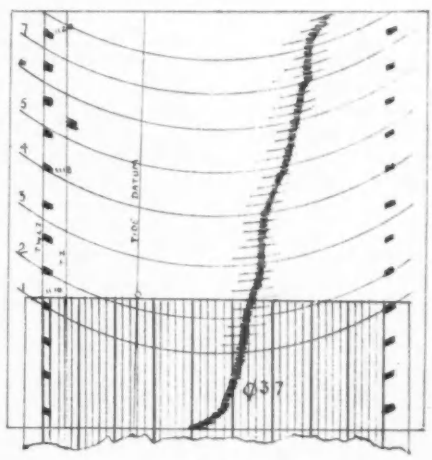


Fig. 3.

Hydrographic Survey Records—continued

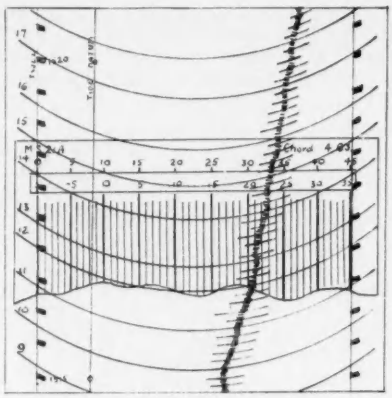


Fig. 4.

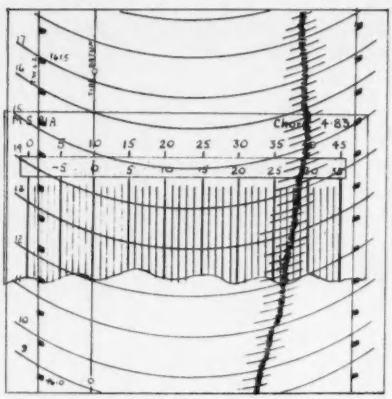


Fig. 5.

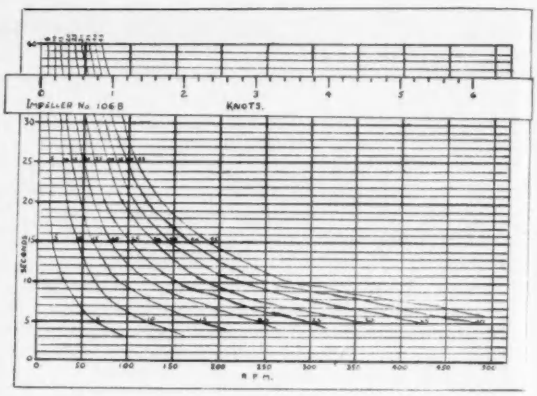


Fig. 6.

If the above adjustments are maintained throughout while sounding, then the records can be dealt with and interpreted in the following way:—

(1) Join up the leading edge of the first interval dots with a straight vertical line. This will give the true water line zero (T.W.L.Z.). (See Fig. 2).

(2) Divide up on the recorded bottom line the number of divisions between fix marks corresponding to the number of soundings required. (See Fig. 2).

(3) Using the interval dots as a guide write at the appropriate place on the record the times corresponding to the tide gauge readings. These interval dots appear at half-minute intervals. (See Fig. 2).

(4) From the set of four different chord lengths select the appropriate scale to allow for the shrinkage of the paper. This is done by testing between the leading edge of left and right interval dots until the nearest matching scale is found. These interval dots are arranged so that if the recorder is properly calibrated for speed, the leading edges are exactly 45-ft. or 90-ft. apart, depending on the speed range used. By using this scale any slight error caused by the difference between the chord length of the scale and the actual chord of the dry record would be unplottable.

(5) With the scale selected, using the bottom calibrated edge, dot the record corresponding to the value of the tidal reduction measured from the true water line zero. This is done at intervals corresponding with the time of reading the tide gauge. Join these dots by a vertical line to give the datum from which to read off the reduced soundings. (See Fig. 3).

(6) With the scale the right way up, place it on the record so that the 0—45-ft. marks coincide with the leading edge of the interval dots (the 0—90-ft. marks if using the deep scale). Note the nearest dark line (even 5-ft. line) to the tide datum line. As this will be the zero, mark this line "O" on the frosted portion of the scale. The remaining values can then be added, i.e. minus 10, minus 5, plus 5, plus 10, plus 15, etc., as necessary. (See Fig. 4).

(7) In order to read off the soundings, place the scale on the record so that the line selected as zero coincides with the tide datum line. The reduced soundings can then be read off direct. (See Fig. 5).

It will be observed that the first division of the scale cannot be used as zero for reading off from a tide datum line. This is due to the fact that the scale is not divided in equal divisions but made up as a chord of the arc described by the stylus. Consequently any movement of the scale across the record will induce an error. However, by using the nearest even 5-ft. line to the tide datum line as zero, the maximum sideways movement of the scale is limited to 2-ft. 6-in. scale reading. This limited amount of alteration will not give any appreciable plottable error.

The printed numerical calibration on the scale is used when reading off soundings direct from the true water line zero without any tidal reduction.

Current Meter Records.

The modern current meter, recording both velocity and direction, enables the surveyor to obtain readings in any static position at frequent intervals and at various depths over a complete tidal cycle. In order to obtain these observations at the frequency required, the results must be recorded for subsequent interpretation. As these recordings are bound to be numerous, it is essential that the time taken to extract the information from them should be reduced to a minimum.

Most recording current meters work on the principle of recording a pulse every given number of revolutions against a time base. Thus it is a simple calculation to determine the revolutions per minute from a given number of revolutions of the impeller in a given number of seconds. Using this R.P.M. value the velocity is then extracted from a calibration curve.

Although this is a simple process, valuable time is lost in carrying out these computations and in reading the calibration curve. However, if a graph, as shown in Fig. 6, is drawn up, the time taken to interpret these records can be reduced very considerably.

In the main this graph consists of a vertical scale in seconds and a horizontal scale in revolutions per minute. Curves are then drawn on the graph for the equivalent number of revolutions corresponding to multiples of the pulses received from the meter. Using the R.P.M. scale of the graph as a base a scale is drawn up from the calibration curve of the impeller to give readings in knots or feet per second as required. Consequently, if the record shows 35 revolutions in 36 seconds, by placing the scale along the 36 seconds horizontal line with the zero of the scale on zero R.P.M., the velocity can be read off at a glance from where the 35 revolutions line cuts the scale.

This method is particularly applicable to the Roberts Current Meter, No. 6, which consists of an underwater unit giving both direction and velocity readings coupled direct to a tape recorder. The meter can be lowered from a boat to any desired depth and observations recorded for future analysis.

In conclusion it is considered that these methods enable the surveyor to interpret the records comfortably and rapidly. This must greatly decrease any possibility of human error occurring due to fatigue or mistakes in mental calculations. Likewise, the time saved over other methods is bound to be invaluable when considered in total with regard to the immense number of records which accumulate during even one day of field work.

Modernisation of Brazilian Ports.

According to reliable reports received from Rio de Janiero, improvements estimated to cost many millions of pounds sterling are recommended for Brazil's seven leading ports, namely, Rio, Santos, Porto Alegre, Belem, Recife, Salvador and Victoria.

A joint U.S.-Brazil Development Commission is now working out complete plans for the modernisation of 22 Brazilian ports, and has already endorsed the Brazilian Government's preliminary plans for Rio and Santos. Twenty-eight new cranes and 14 new locomotives have already been added to the port facilities at Rio de Janiero, whilst a dredging programme is also in hand in 17 ports.

Pneumatic Breakwater at Dover

Protection for Train Ferry Dock

(By a Special Correspondent)

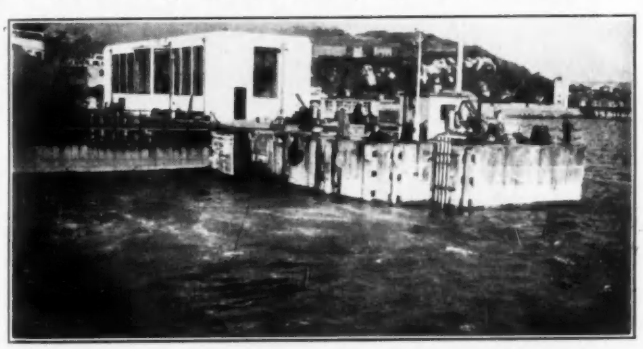
Readers of this Journal will recall an article, in the May 1952 issue, on the possibilities of pneumatic breakwaters for reducing sea waves and swell, together with notes on a design for which patents are pending. An installation along these lines has recently been completed at Dover to meet a special requirement.

The interior of Dover Harbour exhibits a very confused movement of water in windy weather, and particularly when there is a sea running in the Straits. Owing to the number of piers and jetties inside the main breakwaters, there is much clapotis and surging, while the shallowness of large areas of the harbour precludes any assumption that the particles of the larger waves are in orbital motion. It is therefore not possible to approach the problem of wave reduction by the calculations which would apply to true waves in deep water.

The special requirement mentioned above concerns the train ferry dock, the outer gate of which was removed in September for periodic overhaul. In the absence of the outer gate, the inner gate, which opens inwards, is vulnerable to wave and swell during the periods when it is being raised or lowered. The effect of a wave impinging on the inclined surface of the gate is to overload the winding gear, brakes and clutch; and to cause considerable surging of the D.C. supply to the winch motors, notwithstanding the fact that the motors are controlled by manually operated rheostats.

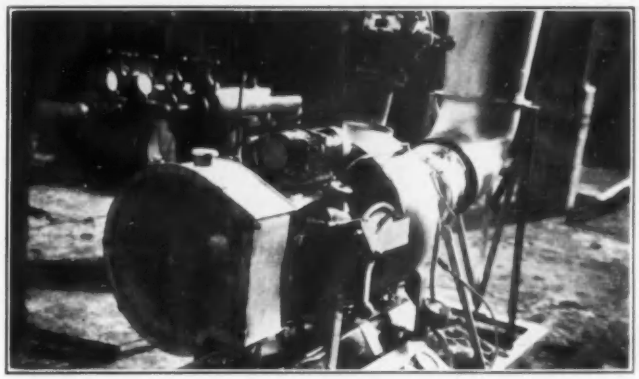
In the interests of maintaining the train ferry service in all weathers in the absence of the outer gate, the Civil Engineer (Southern Region) British Railways, in consultation with the Docks Engineer, Docks and Inland Waterways Executive, recommended that a pneumatic breakwater should be installed across the entrance, to break the force of local waves and swell. The installation was completed on October 13th, and it is now in regular operation, being used whenever the conditions require that the gate should be protected. A brief description of the apparatus follows.

The underwater pipes are in this instance laid on the sea bed, on account of the shallowness of the water, and the need for ships to pass over them. Since the installation is required to operate for only three months, no special precautions have been taken against corrosion, and use has been made of available materials. The pipes are fabricated from lengths of superheater fire tubes from the "Merchant Navy" class of locomotive, welded to 24-ft. lengths, and flanged for convenience of assembly on the site. Each of four parallel pipes is perforated with holes of suitable diameter and pitch, while provision is made for automatic clearance of water. Four risers terminate on the dockside in gate valves, leading via a manifold to the compressor. Pressure gauges are arranged to show the hydrostatic pressure at the perforations at various states of tide, and the working air pressure. The work was carried out by the District Engineer under the direction of the Civil Engineer (Bridge Section) of British Railways (Southern Region).



[*Courtesy of British Railways*

General view of installation. On right air delivery pipes leading from compressor to underwater pipelines. Note waves and swell in foreground and smooth water between the curtain of bubbles and the dock gate.



[*Courtesy of British Railways*

"Palouste" compressor and air delivery manifold.

Compressed air is provided from a "Palouste" gas turbine compressor, supplied and manned by the Blackburn and General Aircraft Co. Ltd. (Turboméca Division). This machine, whose overall dimensions are 19-in. dia. by 42-in. in length, delivers between 500 and 1,800 cu. ft. at 50 p.s.i., with shaft speeds of 26,000 to 35,000 r.p.m. The compressor runs on kerosene, and is started by a 24-volt battery. The "Palouste" is particularly suitable for this project, where a wide range of air output is needed, and where the installation is required to be active at short notice.

Pneumatic Breakwaters, Ltd., to whose specification the installation was built, have taken the opportunity to make a study of the special conditions obtaining inside the harbour. In this they have been assisted by the loan of two wave recorders which were installed by the National Institute of Oceanography. Observations of wave height and frequency are being taken inside and outside the pneumatic breakwater, and it is expected that useful data will accrue regarding the provision of protection in similar cases where the normal operation of a dock or lock is impaired by accident or by maintenance work.

Salvage of Singapore Floating Dock

The Boom Defence and Salvage Department of the Admiralty has now raised the first section of the giant Singapore floating dock. The section, 360-ft. in length and displacing nearly 9,000 tons, is being prepared for towing to the United Kingdom for scrap and, when this preparatory work has been done, the salvage men will turn their attention to raising the remaining section.

The dock was towed to Singapore before the start of World War II and was sunk by the British when Singapore fell. Raised by the Japanese it was being used by them for repairing the Japanese armed merchant cruiser *Shiretoko*, when it was again sunk by an American air attack.

In 1946 the Admiralty refloated the *Shiretoko* and beached her. The Admiralty Salvage vessel *Salvictor* arrived in Singapore last March to take part in the raising of the dock itself. Two Bar class vessels and a shore party of some 62, including 12 divers, have also been engaged for periods during the operation.

Almost totally submerged and badly damaged by the bombing, the wrecked dock presented a major salvage problem. It was found expedient to cut the structure right through athwart ship and this was accomplished by divers using oxy-arc cutters.

About a million cubic feet of air were pressed into the tanks which form the bottom of the dock and part of her sides. It was impossible to use any of the pipe lines, by which these tanks could be blown when the dock was intact and, indeed, divers had to enter the damaged structure to blank off the complex pipe system before blowing could start. They also had to replace buckled plates and render the strained and leaky tanks completely air tight.

The buoyancy of each tank had to be estimated and shown upon a model. It was planned to raise one end of the section first to adjust the buoyancy for stability and then to raise the other end. This plan succeeded and the section came up exactly in accordance with the calculations.

Structural Timbers for Dock Work

II. Marine Borers and Methods of Combating Them.

By B. ALWYN JAY, M.A. (Cantab.), F.L.S.

THE previous article in this series (by Phillip O. Reece, in the issue of November, 1952) reviewed certain factors in the use of timber for the construction of dock and harbour buildings. In particular, questions respecting economics and fire hazard were discussed but, as the structures dealt with were not the type which were in actual contact with sea water, problems concerning attack by marine borers were not mentioned. This subject was, however, briefly referred to in an article by R. P. Woods: " Use of Timber in Docks and Harbours," in the August, 1952, issue. In this article the author discussed the advantages of using timber, including ease of working, strength (especially elasticity), low cost, salvage value, ease of modification of wooden structures, etc. The present article will attempt to go more fully into the question of the attacks by marine borers and suitable protective measures.

A good, brief definition of marine borers is " marine invertibrates which drill into and consequently damage timber and other materials in salt water." It is of interest to note the words " other materials " for these borers drill into rock, cement and poor concrete as well as timber. It is true, however, that they are generally of economic importance only when attacking timber.

Marine borers undoubtedly cause a very considerable amount of damage every year to the timber of docks and harbours in all parts of the world. Engineers have been aware of the problem for many years and the effective protection of structures in sea water is a major concern. It is hoped that the following brief summary of existing knowledge on the subject will be of service.

Classification of Marine Borers.

There are a large number of marine borers found in various parts of the world but the most destructive and widely distributed belong to two groups: molluscs and crustaceans, and may be listed as follows:—

Mollusca—these are bivalves (oysters and clams are included in the group)—*Teredo, Bankia, Martesia, Xylophoga, Pholadidae.*

Crustacea—crustaceans include lobsters, crabs, shrimps and wood lice—*Limnoria, Chelura, Sphraeroma.*

Distribution.

There are hardly any coastal waters which are entirely and continuously free from marine borers of one kind or another. Around the coasts of Great Britain are found principally *Teredo navalis, T. norvegica, Limnoria lignorum* and *Chelura terebrans,* with some *Xylophoga* and *Bankia.* Numerous species of *Teredo* are found in the warm waters of the tropics as are *Martesia* and other genera. Infestation is generally much more severe in tropical than in temperate waters. Generally damage is confined to salt or brackish waters, but certain borers have been reported to live in fresh water in India. Australia and parts of South America.

It is often difficult to be specific with regard to the distribution of marine borers as some (especially *Teredo* in Britain) are very sporadic in the incidence of their attack. There is no known reason for this strange " coming and going."

Teredo.

Timber damaged by *Teredo* is characterised by borings round in cross section, cleanly cut (as if with an auger), free from any of the fine dust or frass usual in borings of land insects and lined with a white, calcareous deposit (see Fig. 1). The number of burrows varies with the intensity of attack from scattered holes to such a mass of closely packed burrows that there is little substance or strength left in the wood. It is of interest to note in the latter case that no burrow intersects another, however close together they may be. The diameter of the burrows varies from $\frac{1}{8}$-in. up to 1-in.; in British waters a diameter of about $\frac{1}{4}$-in. is common.

The extent of the damage is only seen if the wood is split open; the surface shows only minute holes (from 1/100 to 1/30-in. in diameter) which may escape notice, especially if weeds, etc., are present.

Piles are most frequently attacked at the mud line, although American research has shown that attack may occur near the surface in water of high salinity.

The mature *Teredo* is a greyish, slimy and worm-like creature varying in length from a few inches to 4 or even 5-ft. according to species and local conditions, and from $\frac{1}{8}$-in. to 1-in. across. The head—deepest in the wood—is furnished with two shells which are worked back and forth and so cut the burrow. At the tail are two " pallets " at the entrance hole, these can seal off the burrow during unfavourable conditions. Also at the tail are two siphons which

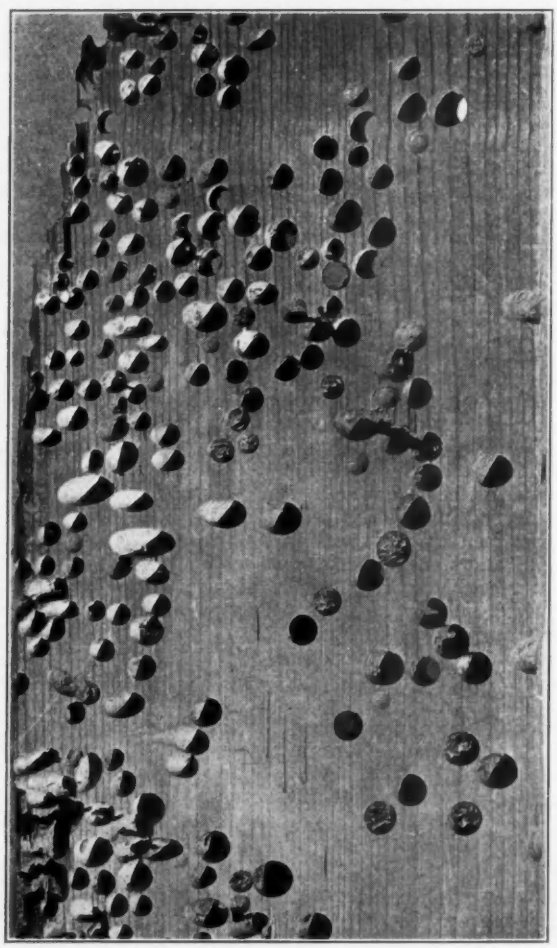


Fig. 1. Typical *Teredo* damage.

project into the water; one of these takes in water and the other exhales it (after it has travelled through the animal), it is, in fact, the respiratory mechanism. The animal can live for a short time (at least two weeks) if the wood is removed from the water; the siphons are withdrawn and the pallets block the entrance.

Reproduction takes place by male sperm being ejected into the sea and fertilising eggs ejected by the female or (as with *T. navalis*) by the sperm being carried into the female through her inhalent siphon. The larvæ develop from the eggs and swim freely; they are like microscopic cockles, about 1/100-in. long. When they alight on wood they bore in for a short way at right angles to the

Structural Timber for Dock Work—continued

grain and then turn and bore along the grain. The tail end of the animal always remains at the entrance hole and the growing *Teredo* bores further into the wood increasing the size of the burrow rapidly until it achieves its maximum width in 1 to 2-in. The main food has been proved to be the wood itself; it was previously thought that the plankton taken in by the siphon was the real food and the wood was only a protective "home." Plankton is, nevertheless, an important part of the diet, providing the protein.

Teredo navalis is the most destructive species in English waters, *T. norvegica* (which is slightly larger) is found further north to within the Arctic Circle in Norway. *T. megotura* is also found in British waters, bus usually in floating timber. Other species of

Fig. 2. *Limnoria* damage with one *Teredo* burrow showing calcareous lining.

Teredo occur in warmer waters, e.g. *T. parksi* in the Pacific islands, etc.

Bankia.

Several species of *Bankia* have been found in British waters but they are not of great significance. In warmer waters, however, they are a major menace, e.g. *B. setacea* on the Pacific coast of America. The damage done is similar to that of *Teredo* as is also its appearance and life history.

Martesia.

Like the clam or mussel, *Martesia* has its entire body enclosed within its shells and so the burrow rarely exceeds 2½-in. long, although it may be 1-in. across. Like *Teredo* these borers have free swimming larvæ which bore entrance holes (about ⅛-in. in diameter) into wood on which they alight. *Martesia* are only found in tropical waters and *M. striata* has caused much damage in the Philippines, Gulf of Mexico, Florida, etc.

Xylophoga.

Xylophoga dorsalis occurs in timber on the British coasts and has been reported to cause damage in the Clyde (including the dock gates at Ardrossan). The animal is somewhat similar in appearance and general life history to *Teredo* but is shorter and has no pallets, the burrows seldom exceed 1½-in. and do not have any calcareous lining.

Pholadidæ.

Most of the members of this family are rock rather than wood borers; they have caused damage to cement and poor concrete (not hard rock aggregate concrete) in Britain and America. More often they bore in soft rock: limestone, sandstone, etc. They are reported to be a serious problem to wood piles in parts of America. Like *Martesia* the body is enclosed in a pair of clam-like shells and cavities are made up to 1½-in. deep in wood; other species make much larger cavities in rock, e.g. the piddock (*Pholas dactylus*), whose burrows may be a foot deep.

Limnoria.

These are the most important of the Crustacean marine borers. *L. lignorum* (the gribble) is common in British waters and is also found in all parts of the world.

Damaged wood has a sponge-like appearance, the surface being broken down by a mass of closely packed holes, each about 1/20-in. in diameter and usually ½-in. deep (see Fig. 2). Attack is usually confined to wood between high and low water, and piles heavily infested assume an hour-glass shape as a result of the damaged surface being progressively washed away in this region.

Limnoria appear like minute wood lice, about ¼-in. long. Breeding takes place by the female carrying 8—12 eggs in a brood pouch, these hatch out and the young are very similar to the parents except in size; they do not normally wander far but attack wood in the vicinity of their birth. Their food consists solely of wood, they do not take in plankton in the same way that *Teredo* do.

Chelura.

Very similar in appearance and habits to *Limnoria*, *Chelura* are generally associated with them in attacks on wood. *C. terebrans* is usually found with *L. lignorum* in British waters. Australian research workers claim to have proved that *C. cambrica* does not initiate attack and is not injurious to wood, but live in holes made by *Limnoria*.

Sphaeroma.

These are similar to *Limnoria* but larger, up to ½-in. long and ¼-in. across. The damage caused is similar but the holes, of course, are larger—they may be 3—4-in. deep. *Sphaeroma* are mostly found in warmer waters than European and occur occasionally in fresh water.

Environmental Influences.

Many marine borers are sensitive to environmental influences and populations may change rapidly with changes of environment. The following have been found to be the most important influences:

Salinity: this is the most important single factor; most marine boreres need salt, or at least brackish water. For this reason the Thames above Gravesend, for example, is free from borers. Sea water has about 30—35 parts of salt per 1,000 and the activity of Teredo decreases markedly below 9 parts and six weeks at 4—5 parts is fatal. Teredo can, however, tolerate fluctuating salinities to some extent as it can seal its burrow with its pallets. *Limnoria* need 30 parts salt for full activity and are inhibited by 16—20 parts; 24 hours at 6.5 parts is reckoned to be fatal. Some *Bankia* need 20 parts or more, e.g. *B. setacea*, others can exist at 7—10, e.g. *B. gouldi*.

Temperature is mainly of importance in the breeding season. *Teredo*, for example, must have fairly warm water for egg laying and for the larvæ to exist. The heaviest period of attack is in

Structural Timber for Dock Work—continued

the warm months. The effect of temperature is reduced once the *Teredo* is in the wood, boring continues, in fact, until the temperature is nearly at freezing point. *Limnoria* are generally less affected by temperature than *Teredo*. Where the temperature of harbour water is raised by introduction of hot water (e.g. from a power station), there appears to be a tendency for attack to intensify.

Pollution: industrial effluents, chemicals, oils, etc., also mud in suspension, nearly always reduce borer activity. There is some doubt, however, about domestic sewage, some authorities stating that it is actually beneficial to *Teredo* and others that it is the reverse. All are agreed that this form of pollution has no effect on *Limnoria*.

Dissolved gases and hydrogen-ion concentration: disolved oxygen is necessary for respiration and hydrogen sulphide in any but tiny

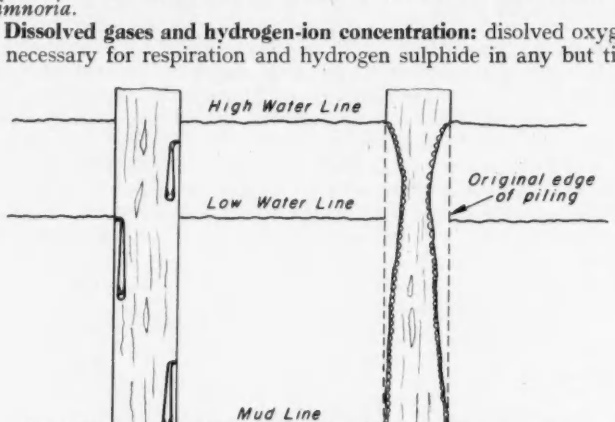


Fig. 3. Diagram showing method of marine borer attack.

quantities is fatal; no actual figures of concentrations exist for either chemical. Seawater is slightly alkaline, with a pH of 7.5 to 8.5; any change from this range, up or down, has a very marked effect on borer activity. In practice this hydrogen-ion concentration is not normally very important, except where pollution causes acidity.

Current: strong currents appear to preclude attack by marine borers. American tests indicate that currents of about two knots seemed to preclude attack in Florida waters.

Light: little is known as to the effect of light, but *Teredo* larvæ tend to be much more active in the dark.

COMBATING MARINE BORERS

Four broad methods can be used in combating marine borers:—

(1) Use of resistant kinds of timber;
(2) Protecting the wood by treatment with a preservative;
(3) Protecting the wood by covering the surface with metal or concrete;
(4) Killing the borers by means of depth charges, poisons added to the water, reducing the salinity of the water, or other means.

Resistant Timbers.

A number of timbers have proved to be highly resistant to attack: greenheart, turpentine, angelique (basra locus), jarrah and ekki, to name only a few. This question was discussed fully in R. P. Woods' previous article in this Journal[12] and so will not be enlarged upon now.

Preservative Treatment.

Thorough treatment with a suitable preservative is very effective against all types of marine borers. Coal tar creosote is most commonly used and has been found the most generally satisfactory, in fact, Bryan[1] states " Any species of timber efficiently impregnated with creosote is practically immune to marine borer attack in home waters. In tropical waters it is highly resistant to attack and will have a life of many years."

Experiments[1] have shown that a proprietary acid copper chrome preservative (Celcure) gives promise of being equally efficient.

The method of applying the preservative is extremely important and pressure treatment by the full-cell or Bethel method is best. With resistant timbers such as Douglas fir incising and long pressing periods are also necessary. Hot and cold open tank treatment can sometimes be used with very permeable species of with round poles —where the sapwood is thick. Surface brushing is useless. Any bolt holes or other cuts in the timber must be thoroughly treated (or, very much better, not made after pressure treatment). The top end of piles should be given a generous coating of tar or bitumen.

The Floating Collar.

An ingenious method has been invented in Australia[7] called the " floating collar," to protect piles and can be used to treat piles in situ infected with *Sphaeroma* or *Limnoria*. It has only been applied to round piles; these are widely used in the U.S.A. and Australia but British engineers prefer the easy and neat joints that can be made with squared timbers (an article on this subject will appear later in this series). With some modification a floating collar could doubtless be applied to square piles.

The method provides protection only against attack concentrated between low and high water levels (as with *Limnoria* and other Crustaceans). The collar itself consists of a round, hinged metal casing, supported on floats, with the top about 18-in. above water level to counteract wave action. The length may be up to 8-ft., the longer lengths provide for additional depth of pile surface covered below the low water mark. The width is such as to leave a small annular space (about 2-in.) between the collar and the pile. The collar can be floated into position and then the preservative poured on to the water to cover the area between the collar and the pile (see Fig. 4); about a gallon of creosote is generally used. Any toxic, relatively non-soluble liquid with a suitable specific gravity below 1.00 can be used—creosote has been used mainly. A ring of preservative thus floats on the water and moves up and down with the tide, treating the pile in the vulnerable area as it moves. The water below the preservative is gradually forced through the open bottom of the cylinder but no preservative escapes since a

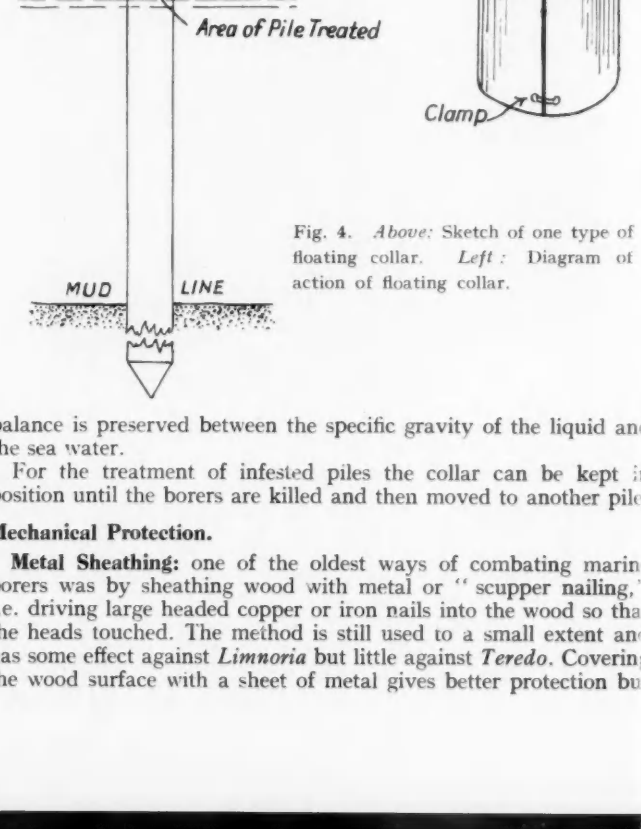


Fig. 4. *Above:* Sketch of one type of floating collar. *Left:* Diagram of action of floating collar.

balance is preserved between the specific gravity of the liquid and the sea water.

For the treatment of infested piles the collar can be kept in position until the borers are killed and then moved to another pile.

Mechanical Protection.

Metal Sheathing: one of the oldest ways of combating marine borers was by sheathing wood with metal or " scupper nailing," i.e. driving large headed copper or iron nails into the wood so that the heads touched. The method is still used to a small extent and has some effect against *Limnoria* but little against *Teredo*. Covering the wood surface with a sheet of metal gives better protection but

Structural Timber for Dock Work– continued

is normally uneconomic. Copper is best but is subject to abrasion (and theft), zinc is good but expensive, Munz metal has also been used but the alloy (of zinc and copper) must be homogeneous or electrolytic action may be set up. Nails must be of the same metal as the sheathing metal. The sheathing is, of course, fixed before the pile is driven.

Concrete Encasements: numerous methods have been developed for protecting timber piles with concrete, two that have proved successful in America and elsewhere are : (a) **Precast concrete jackets:** they are generally used with round piles which are driven butt down so that the jacket may be placed over the pile and lowered or driven into the bottom material. The space between the pile and the jacket is sealed by grouting through a tremie pipe to about 20-ft. from the top of the jacket; the water is removed from the remaining space which is filled with concrete (see Fig. 5). This form of protection has proved efficient, being affected only by those factors influencing the life of good concrete; care is necessary in handling to avoid cracking. In the U.S.A. the cost is not so high as solid concrete piles; (b) **Gunite or shotcrete:** this is essentially a method of applying concrete under pressure, and has been used successfully for some time in America. So far, round piles only appear to have been used and these may be unseasoned or, if seasoned, they are first wetted. The pile is covered with galvanised 2-in. x 2-in. mesh which is held about 1-in. from the surface of the pile by special clips. The concrete is then shot on to a depth of about 2-in., some 3 to 5-ft. of the butt is left untreated until after driving. The coating may be any length, according to the attack of borers but is normally from about 2-ft. from the top to below the mud line. It is claimed that piles treated in this way can be driven deeper than precast concrete piles and harder than timber piles; (c) **Other forms of mechanical protection:** include leaving the bark intact on round piles. This with certain species delays attack for a short time but is purely a temporary expedient. An older method is the charring of the wood, but here the abrasion of the sea very quickly breaks away the charred surface and leaves the wood open to attack.

Eradication of Marine Borers.

So far no really successful method has been discovered to kill all types of marine borers, either when free swimming or in timber.

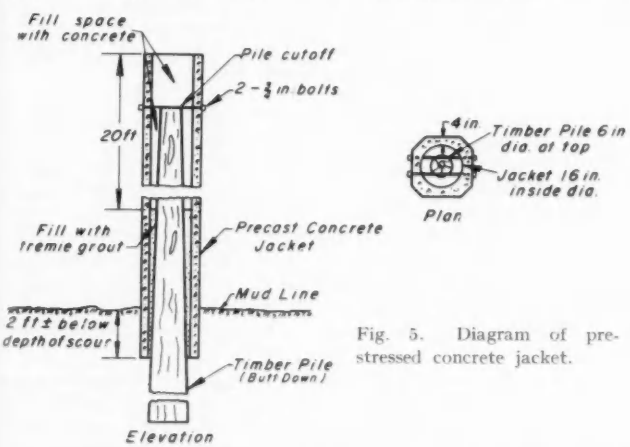


Fig. 5. Diagram of prestressed concrete jacket.

However, the following methods have been tried and some, at least, have been successful in certain localities, e.g. concrete casing and the use of the floating collar.

Concrete Encasement: piles which are affected by marine borers may be strengthened and at the same time the borers killed by encasing the piles with concrete. There are a number of methods of doing this, for example, the American Presscrete method. Here metal forms are dropped round piles and the water in the annular space ejected by compressed air. Dense concrete is then pumped into the space at a pressure of between 5,000 and 8,000 lbs. per sq. ft. It is introduced to the bottom of the form and is compacted against a special head towards the top of the pile. The form is finally removed when the concrete has set.

Plastic Coating: Johnson[7] in Australia has developed a plastic coating consisting of one part crude tar at 72°, two parts cement, four parts medium sand (perfectly dry). It is claimed that the tar not only acts as a coating and a binder for the solids in the mastic but provides a medium which even in normal circumstances is resistant to marine borer attack. This mastic can be applied under water or as a preventative coating before driving.

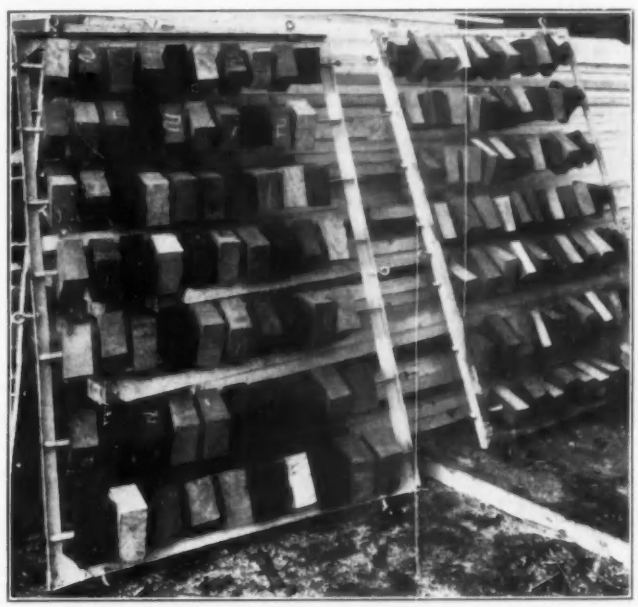


Fig. 6. Research work on resistant timbers. Frames ready for sinking.

Toxic Substances in the Water: Chemicals which are slowly soluble in water can be added to the water but the disadvantage is that they kill all marine life as well as borers and have to be repeated frequently, probably every two to four weeks during the warm weather. There may also be legal complications.

Depth Charges: The use of depth charges or underwater dynamite explosions near wooden structures affected have proved successful, although here again other marine life suffers and the kill is only in the immediate vicinity of the explosion. It is, however, one of the most successful methods of eradication.

Reduction of Salinity: Where circumstances allow, fresh water may be pumped into the sea to reduce salinity. This was, for example, carried out at Hartlepool to kill marine borers in a log storage area.

Electrolysis of water with the object of releasing the chlorine can be effective but the method needs to be done almost continuously for complete success. One set of experiments showed that *Teredo* merely stopped feeding when the concentration of chlorine was high.

Floating Collar: This has been fully described earlier on, and used successfully to eradicate Crustacean borers in Australia.

Research.

Continuous research is being carried out in various parts of the world to learn more of the biology of the marine borers and ways of combating them. One line of research concerns resistant timbers, e.g. that conducted by the Institute of Civil Engineers, both in British and tropical waters, also the small scale tests by the Timber Development Association at Shoreham (see Fig. 6) and other researches dealing with wood preservation, eradication of borers, etc. The Sydney Harbour Trust Commissioners and the U.S. Navy are two examples of bodies responsible for valuable research work in this field.

Timber has proved itself to be a very valuable material for dock and harbour work, and as research work continues towards the overcoming of some of its shortcomings it should be even more valuable in course of time.

The experiences of those using timber for marine work would

Structural Timber for Dock Work—continued

form a valuable addition to the various research projects mentioned above. It is suggested, therefore, that anyone willing to pass on their experience with regard to timber and marine borers should write to either the author of this article or to the Editor so that a volume of useful factual data can be built up from various parts of the world.

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Forest Products Research

Review of Progress during 1951

According to the report of the Forest Products Research Board for 1951, industrialists are now seeking advice from the Forest Products Research Laboratory before new projects are started and not only on difficulties which arise after work has been put in hand. The report interprets this tendency as showing that the practical value of scientific information to industry is now more widely realised in the timber and associated industries.

Tropical Timbers and Their Uses.

The Report of the Director of the Forest Products Research Laboratory, which is included in the same publication, outlines the work carried out in discovering the characteristics of the many tropical hardwoods which are being imported in order to conserve the limited supplies of traditional timbers.

Investigations have included testing for strength, durability and resistance to abrasion, and study of the behaviour of the timbers during seasoning, machining, steam bending, nailing and impregnation of preservatives. A classified list of more than a hundred hardwoods detailing their properties and suitable uses was published during the year for the guidance of timber users. (Hardwoods for building and general purposes).

The Tropical Testing House.

A tropical testing house, added to the equipment of the Laboratory during the year, has dry and wet rooms in which tropical temperature and humidity cycles can be maintained for test purposes. It includes a workroom in which any constant air temperature and humidity can be maintained and the effect of the sun's heat can be simulated by infra-red lamps, the room being large enough to accommodate assemblies such as aeroplane wings for investigation of glueing techniques. The testing house is also being used for a limited number of commercial tropical storage tests.

Decay of Timber in Boats.

The prevalence of decay in the timbers of small craft is a widespread problem. It has been estimated that one and a half million pounds is spent yearly on the repair of yachts alone, with a further million on the repair of open boats, fishing and commercial craft. The Laboratory is co-operating with naval architects and yacht designers in making available information on the subject. The problem is of considerable importance also in many tropical countries and extensive repairs are often needed to modern craft operating in fresh water overseas. Samples of fungi and of decayed timbers from vessels operating on East African lakes are being examined at the laboratory in an attempt to find the best methods of preserving this type of craft.

Other Research.

During the year the laboratory has also continued its work on wood structures and timber mechanics and on such allied subjects as seasoning, the properties of composite woods, machining research, mycology and entomology.

A new structures testing laboratory capable of testing full scale industrial type trusses and other structures was completed and brought into use during the year.

"Forest Products Research, 1951," published by Her Majesty's Stationery Office for the Department of Scientific and Industrial Research. Price 3s. (75 cents U.S.A.) by post 3s. 1½d.

Some Designs for Flexible Fenders*

By D. H. LITTLE, B.Sc. (Eng.), A.M.I.C.E.

Open-piled jetties or wharves are the cheapest maritime berths to construct, but being light and rigid they must be protected from berthing impacts by fendering systems of adequate flexibility. A mass of 1,000 tons moving at a speed of 1-ft. per second has an approximate kinetic energy of 50 inch tons. If it is assumed that half the weight of a vessel is effective when it comes alongside (i.e. that first the bow strikes a fender and then the stern swings round and strikes a second blow) then a vessel of 40,000 tons coming alongside at a speed of 1-ft. per second will require a fender of 1,000 inch tons capacity to receive it safely. Similarly a vessel of 1,000 tons will require 25 inch tons.

Fendering systems of this wide range are now becoming common practice so that open-piled jetties can be built to cater for the largest of ships and in comparatively exposed waters.

The Admiralty almost invariably provide some special flexibility —in addition to the inherent property of the fender pile itself—in the fendering systems of their jetties and wharves, and a detailed description is given of twenty representative designs selected from work done over the past ten years. Some of these were built during the war either on an operational basis or at a time when really appropriate materials were not available. They met with varying success, and attention is drawn to the experience to be gained from them.

Post-war developments in the use of rubber in shear—by bonding the rubber to metal plates—are described in some detail. Single rubber units cannot provide much more than 75 inch tons without getting too large, but a number of units grouped in series can give 600 inch tons. For greater values swinging clumps of concrete—essentially a gravity device—are more appropriate, and experience gained at three different jetties with such fenders is included.

All experience on all types of fendering—large and small capacities—leads to the conclusion that longitudinal or glancing blows are as important as those at right angles to the jetty line. They are, however, most difficult to cater for and future development work will be mostly concerned with this particular aspect of the fendering problem.

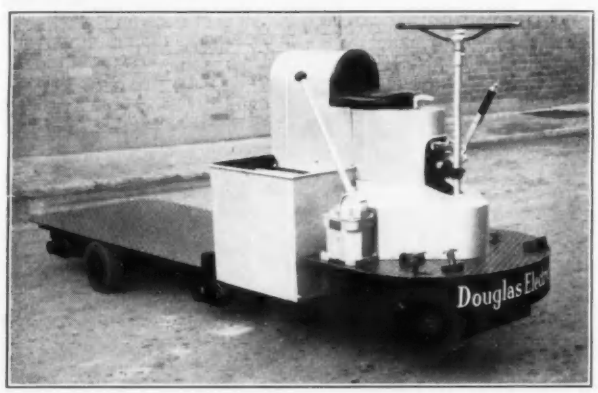
*Summary of Paper read before the Maritime and Waterways Division of the Institution of Civil Engineers on 21st October 1952.

Manufacturers' Announcements

New Electric Works Truck

A new aid to swift handling in works and factories is announced by Douglas (Sales and Service), Ltd., of Bristol. The new vehicle is the Douglas Electric Works Truck, which carries a stage further the high manœuvrability of the same firm's petrol-driven works truck. The price is £350.

A notable improvement is a new and simple control which gives forward or reverse motion without turning the front driving wheel completely round. The handle for this newly developed control is conveniently placed forward of the driver's seat, and has a neutral position to prevent the truck being put into motion when stationary.



Another new feature is the special safety-control foot-switch, which must be depressed before the truck can be started and while it is running. The accelerator is also foot-operated, and the truck is equipped with foot and hand brakes.

The platform of the truck is elevated and lowered by a hand-pump which can be operated from the driver's seat. The ease with which the platform can be raised is considerable in proportion to the driver's simple manual operation.

Charging of the batteries is carried out by removing the driver's seat and plugging in the exposed charging plug socket. Removal of the seat prevents the truck being driven away accidentally while charging is in progress.

A Hydraulic Truck Loader

The HIAB hydraulic truck loader recently introduced into this country from Sweden, has a capacity of 10 cwt.—1 ton, and is a versatile lorry-mounted unit easily fitted and simple in operation. The vertical ram unit is mounted on a transverse base on the chassis frame immediately behind the cab, thereby ensuring that the hoist load is evenly spaced over a considerable area of the frame. No structural alterations are required as the HIAB unit is secured by the U-bolts supplied. The horizontal hoist arm or jib has three telescopic sections, giving a lifting capacity of one ton (with block) at 4-ft. 6-in.—5-ft. 9-in. range and up to 10 cwt. at 8-ft. 2-in.—11-ft. 6-in. range. In its highest position the jib arm is directed upward and this makes the equipment especially suitable for loading to or from upper floor level.

Operation is from the gearbox power take-off and various types of pump are available. Control of the elevating, hoisting and slewing movements is by levers brought out to both sides of the cab. The jib has a lateral swing of 45° to either side of the vehicle, under control of the operator, and when fully extended, the maximum height of hook from ground level is approximately 20-ft. The maximum reach is approximately 25-ft. on either side of the platform or 12-ft. below ground level. A series of scoops and grabs is available for handling building materials (sand, gravel, etc.), timber, sacks or barrels.

The price of the HIAB unit is approximately £350, exclusive of fitting. J. Goddard and Company, 14/16, Newgate Street, Chester, are responsible for importation; Beacon Motors, Limited, Aston Road, Birmingham, 6, besides being trade representatives for Warwick, Worcester and Staffordshire, can also supply operators in any part of the country.

Demonstration of new loader with jib partly extended.

Developments in Anti-Corrosive Paints

Since the war the value of chlorinated rubber as a basis for a corrosive-resisting coating has steadily increased. Particularly suitable for marine conditions where the corrosive effect of sea water on steel and other metals is more rapid and severe than usual, are the latest developments of Detel Products, Ltd., of South Ruislip, Middlesex, whose new A.L.C. Primer has been specially formulated for protection against sea water.

This new primer is not effective by itself but requires an application of Detel top coat, Grade "A," for example, being preferable for ordinary general use. It is stated that independent tests on mild steel plates have shown no deterioration after some 12 months' salt spray, even on the edges, and corrosion creep is very slow and on removal of the protective coats the metal surface remained bright and clean.

Another interesting example is the internal protection of salt water evaporators, the primer in this case being specified with top coats of "P" grade Detel. Successful tests have also been carried out with sea water up to 100° C. for a four month period. This primer, it is claimed, will withstand temperatures up to 200° C. dry heat, being also effective in acid and alkaline conditions where the paint system is exposed to hot caustic soda solutions. These coatings have many uses in marine conditions for the protection of cranes, floating docks, piers, gutters, railings, etc., and can be applied to any clean iron or steel surface requiring no other equipment than a paint brush and no skilled labour to operate. These paints dry quickly, thereby shortening the time of vessels spent in dry dock. A.L.C. Primer is entirely different from other protective and anti-corrosive compositions because its action does not depend on the medium or bonding material used but on the pigment itself.

Detel coatings were extensively employed during the war by the Admiralty and one particularly interesting example, the news of which can now be released was that used on the well-known "Pencil" delayed action fuse. This fuse was an outstanding

ERRATA

In the article entitled "Seiche in Harbours," which appeared on pages 177-180 of the October issue of this Journal, we regret that there were some errors in each of the four equations. The correct formulæ should read:—

$$\eta = J_n(kr)\cos(n\theta)\cos\frac{2\pi t}{T} \qquad (1)$$

$$\left(\frac{2\pi}{T}\right)^2 = gk\tanh(kh) \qquad (2)$$

$$\eta = A\cos\frac{\pi mx}{a}\cos\frac{\pi nv}{b} \qquad (3)$$

$$\left(\frac{1}{\pi}\right)^2 = \left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2 \qquad (4)$$

Manufacturers Announcements—continued

success because of its reliability and it need hardly be stressed that everything depended on the protection of the primer, without which the fuse was useless.

Another new application to their range is Detel copper coating for wood hulls. This contains 80% of metallic copper on which it relies for its anti-fouling and protective properties. It is applied by brush over its special undercoat giving protection from the attacks of marine borers. It has been tested in India and at Gibraltar and reported as completely satisfactory against the *Teredo Navalis* and the *Limnoria Lignorum* borer worms.

It should be mentioned that the initial coating with Detel copper must be done when the craft is in dry dock, hauled up or slipped, it cannot be done between tides as it is necessary for each coat to dry out thoroughly after application to a dry hull. The final coat may, however, be applied weeks before it is desired to put the craft in the water. Best results are obtained on a new or burnt off hull. This coating has substantially the same properties as copper sheathing and consequently the usual protection against electrolytic action must therefore be taken. It must not be applied over iron and steel fittings to avoid the possibility of electrolytic corrosion. Iron fittings and iron keels must be protected by two coats of an efficient electrolytic insulator, such as Detel Red " A " and an anti-fouling composition, applied over it.

Publications Received

Corrosion-Resistant Materials in Marine Engineering by L. W. Johnson, Met., M.I.Mech.E., F.I.M., and E. J. Bradbury, M.Eng., A.M.I.Mech.E., A.I.M.

Corrosion problems in marine engineering vary considerably, but it can be said that materials are available to resist practically all conditions of service. Although the use of such a material may not always be justifiable, by slight re-design and by choosing a more resistant alloy, economies and improved life are often possible. This publication, which is based on a paper presented by the same authors to the Institute of Marine Engineers, will be found helpful in making such a choice.

After a brief introduction to the theoretical aspects of corrosion and a consideration of causes—products of combustion of fuel, boiler water impurities, steam, sea water, the atmosphere—much useful data is given on the corrosion-resisting materials commonly in use. The materials covered include copper and special brass and bronze alloys, cupro-nickel, aluminium alloys, corrosion-resisting and heat-resisting steels and cast irons, and protective metallic coatings. A useful table shows the relative abilities of a wide range of copper alloys to resist different forms of attack by sea water. A comprehensive bibliography is included. Copies of this publication may be obtained free from The Mond Nickel Company Limited, Sunderland House, Curzon Street, London, W.1.

The Recruitment and Training of Senior Staff. This booklet has recently been issued by The United Steel Companies, Ltd., one of the largest iron and steelmaking concerns in the United Kingdom. Some 30,000 people are employed by this company, who manufacture a wide range of steel, chemical, and engineering products in a number of different works and branches throughout the country. The Company's undertakings provide wide scope for the exercise of varied ability and skill and ample opportunity for those who have the aptitude for and seek positions of responsibility. Copies of the booklet can be obtained from the Company at 17, Westbourne Road, Sheffield, 10.

A Stitch in Time. Published by the Igranic Electric Co., Ltd., Bedford, this booklet deals with some of the fundamental principles of Electric Motor Control Gear Maintenance and the correct functioning of various types of starters. It is not a comprehensive service manual, but will be welcomed as a reminder of the vital importance of efficient maintenance.

SITUATION WANTED

TECHNICAL DIRECTOR, Mediterranean based salvage and general shipping enterprise, aged 38, with 12 years' service Royal Navy, speaking fluent French and Italian, and having extensive experience directing major marine undertakings, seeks stable position of responsibility with firm engaged in salvage, port construction, scrap recovery or other shipping activities. Available New Year. Box No. 147, " The Dock & Harbour Authority," 19, Harcourt Street, London, W.1.

PUBLIC APPOINTMENTS

CIVIL ENGINEERING CONTRACTORS with office near London require qualified Engineer to supervise various contracts in South and Midlands embracing shuttering, reinforced concrete, piling, deep excavations, factory construction, sewerage and harbour works. Knowledge of modern plant, unit costing, bonus scheme and office administration necessary. Applicant should be competent to negotiate with consultants and Local Authority Engineers. The proposed salary, including bonus, will be from £1,800-£2,200 per annum, depending on ability and subject to revision later. Car supplied with expenses, also Pension Scheme in operation. Apply: Box No. 145, " The Dock & Harbour Authority," 19, Harcourt Street, London, W.1.

LANDING & SHIPPING COMPANY OF EAST AFRICA LIMITED, Cargo Handling Contractors at East African Ports for the East African Railways and Harbours, invite applications for the position of Deputy General Manager. Applicants must possess executive ability with wide practical experience of all aspects of cargo handling.

Salary offered £1,500 per annum plus a temporary allowance, which at present amounts to £300 per annum.

Housing provided but will be charged for at the rate of £260 per annum.

Applications should be forwarded to the Company, P.O. Box 368, Mombasa, Kenya, when arrangements will be made for suitable applicants to be interviewed in London and further particulars supplied.

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THE GOVERNMENT OF THE FEDERATION OF MALAYA have for sale the steam driven steel hopper barge, " MORIB ". Built 1944 by Wm. Simons. Dimensions about 162' x 33' x 14', moulded depth 15'. Tonnage gross 682, net 302 tons. Hopper capacity 800 tons on mean loaded draft of 12 feet 9 inches. Oil or coal fired. Speed about 9 knots. The vessel is offered as and where she lies at Port Swettenham. Tenders will close at noon on 31st January, 1953, and should be addressed (in sealed envelope marked " TENDER FOR MORIB ") to the Director of Marine, Penang, Federation of Malaya, with whom arrangements to inspect the vessel may be made.

Further particulars obtainable from Crown Agents for the Colonies, 4, Millbank, London, S.W.1. (Reference O/Prod.1524), or from the Director of Marine, Penang.

WANTED

WANTED URGENTLY: One copy of " Port Economics " by Brysson Cunningham. Anyone with copy for disposal is requested to write, stating price required, to Box No. 146, " The Dock & Harbour Authority," 19, Harcourt Street, London, W.1.

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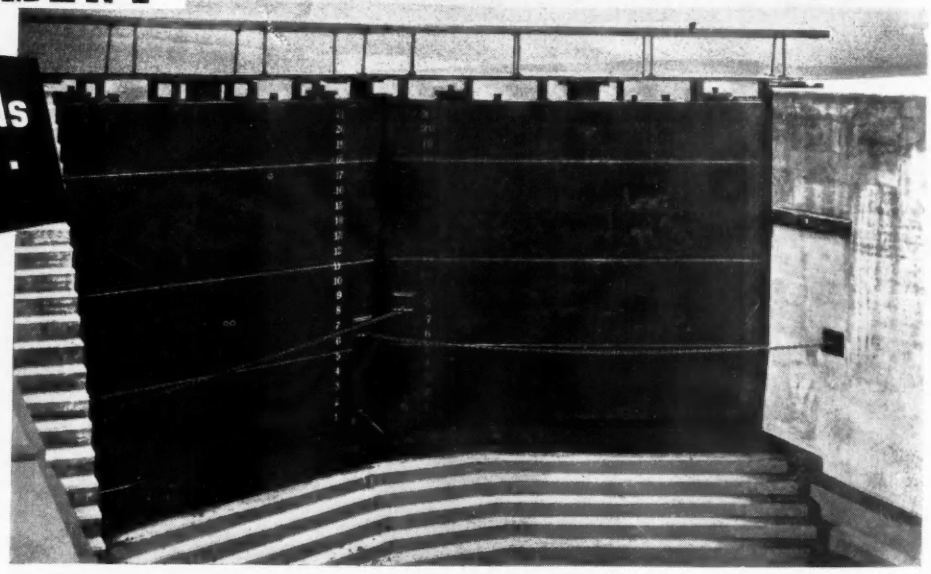

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★ *The illustration shows a pair of all-welded dock gates in position at Blyth.*

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217—Rd.

Mr. SMITH, technologist with a large firm of constructional engineers, gives a trainee a tip about anti-rust precautions

"What you need for this kind of job is a bituminous paint..."

"...and the bituminous paint you'll be using in this firm is Presomet."

"*Presomet?*"

"Yes—it's a by-product of coal, made by the National Coal Board—and it's better, we find, than ordinary bituminous paints because it's constant in quality. It's cheaper too, which is an important point."

"*What's the advantage of Presomet over ordinary paint?*"

"Well, it's like this. Many ordinary paints absorb water readily under certain conditions. Now when such paints are applied to iron or steel, this moisture spreads over the surface of the metal, and you may get the paint lifting up into a bubble and cracking; and of course the metal begins to rust."

"*You mean the water actually gets between the paint and the metal?*"

"Yes—and another thing. By electrolytic action the moisture causes rust at any point liable to attack, such as a trace of pitting. Then the rust builds up, and the paint bulges and cracks."

"*So that's why you sometimes get little lumps of rust under the paint film?*"

"Exactly—but with Presomet it's different. Not only does it adhere strongly to the metal surfaces, but it absorbs very little moisture; and electrolytic action will not take place unless moisture is present. So you don't get the same tendency to lifting and blistering."

Three Grades: Presomet is made in light, medium and heavy grades—the latter for the most severe conditions of service. It has great covering power, and is readily applied by unskilled labour, forming a glossy black coat resistant to wear and rough usage.

Further information and technical advice on any proposed application of Presomet will gladly be given on request

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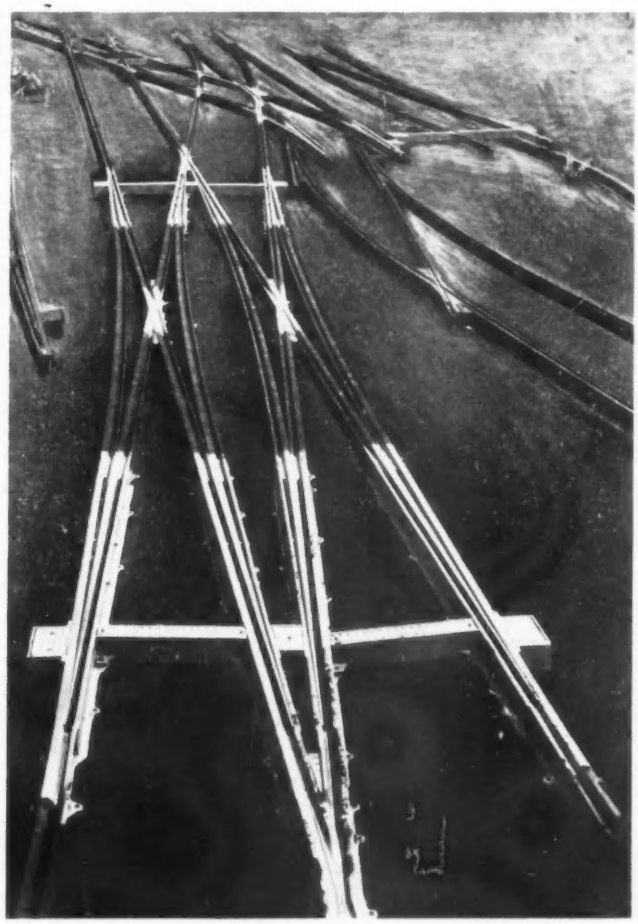
TRACKWORK

for Docks and Harbours



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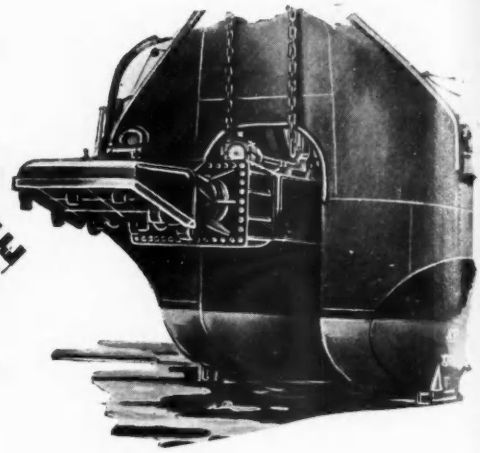

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